The Global Economy

Business Cycle Theory

NYU STERN

Roadmap

- News
- Aggregate demand and supply: theory
- Quantity theory
- Hyperinflations

Mishkin: Inflation Targeting (FT 10-24-10)

- Inflation objective guards against:
  - Falling inflation expectations amid excess capacity
  - Rising inflation expectations amid monetary expansion
- Stable inflation expectations give Fed flexibility
- How to Proceed:
  - FOMC announces numerical target, subject to modification only for "sound economic reasons, such as improvements in the measurement of inflation or changes in the structure of the economy."

Romer: Nominal GDP Targeting

NYTimes 10-29-11

- Set NGDP goal (2% inflation + 2½% growth = 4½%)
- Extend NGDP trend from 2007: 10% shortfall
- Pursue expansionary target ("whatever it takes") using various unconventional policies
- Transmission mechanism: raise inflation expectations and lower ex ante real interest rate
- Romer's evidence: Exiting the Gold Standard

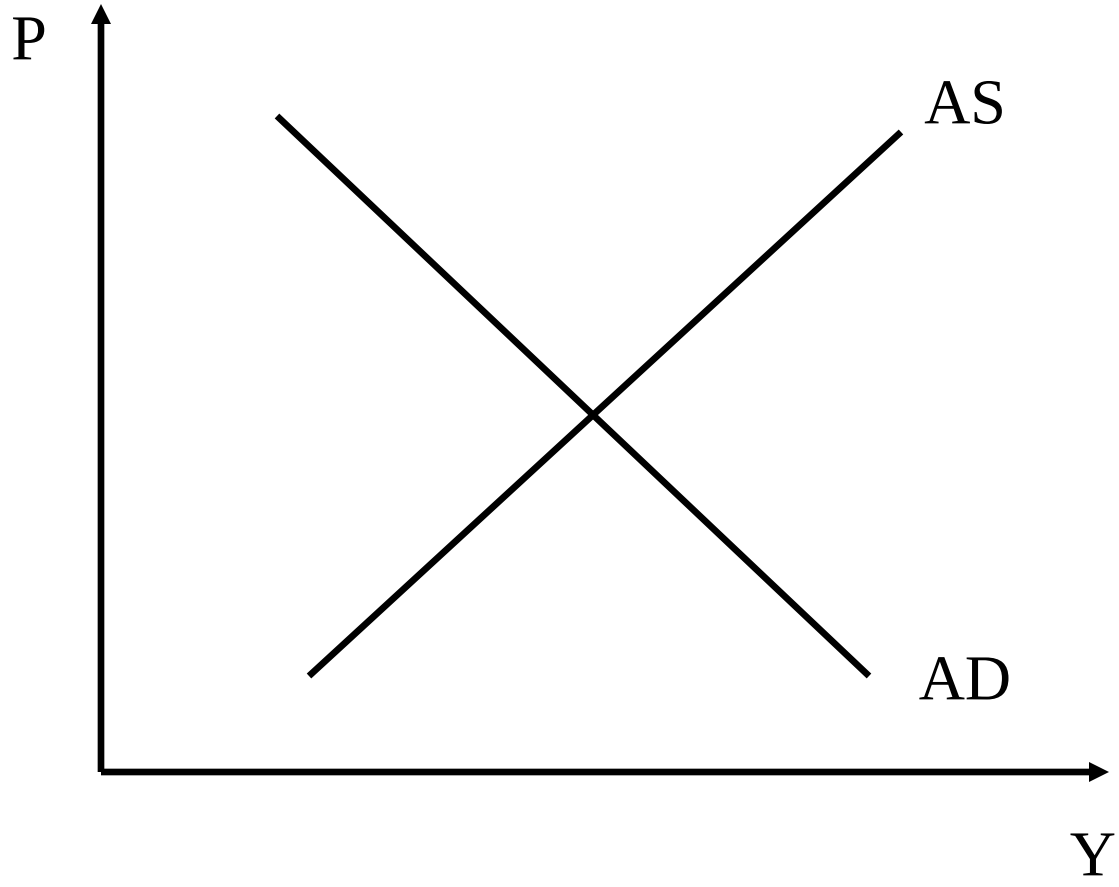
Next week

- Put together money and business cycles
- Monetary policy
  - Quantity theory + AD/AS
  - Interest rates and Taylor rules
  - Unconventional monetary policy

Aggregate supply and demand

- Adapt supply and demand to whole economy
- Axes
  - P is price level (could substitute π = inflation)
  - Y is real GDP
- Curves
  - Supply focuses on production of goods
  - Demand focuses on purchase of goods
- Why do they look like this?

Aggregate supply and demand



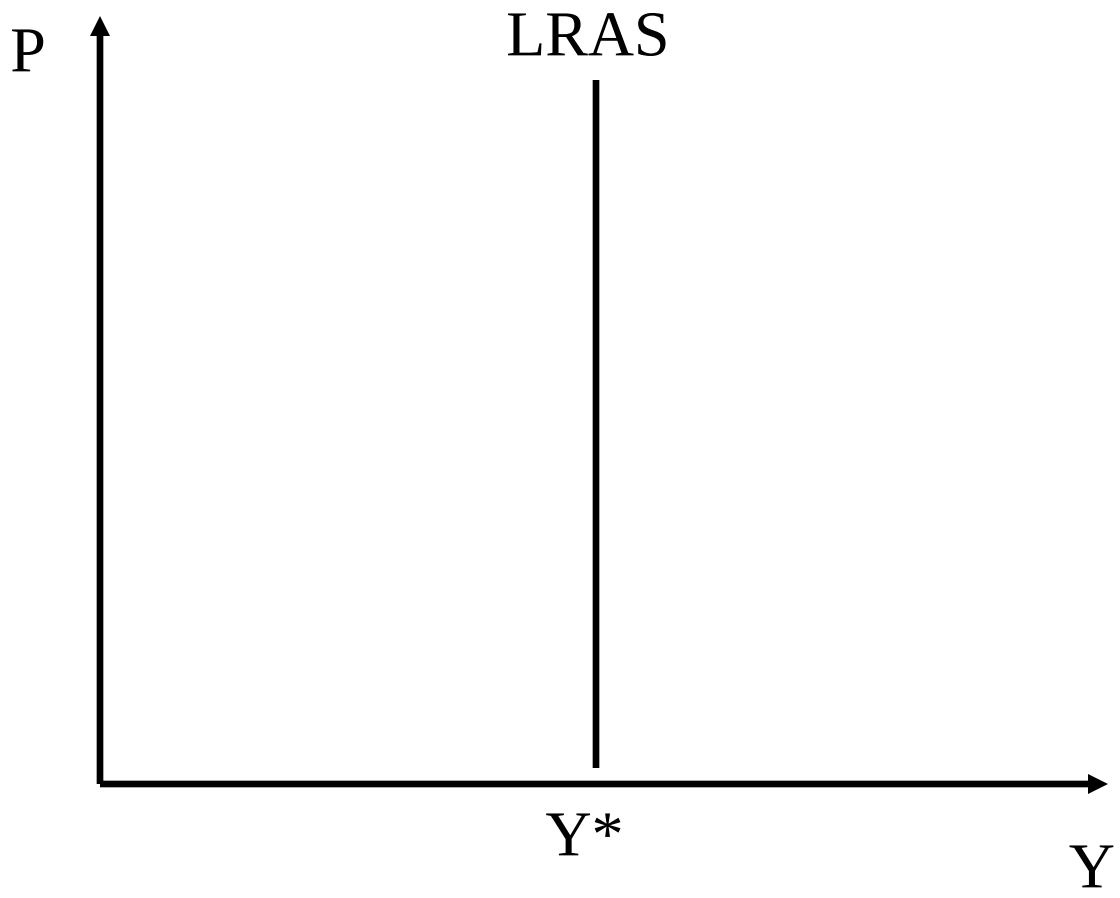
Aggregate supply I

- Classical version ["long run"]
- Production function

$$Y = A K^{\alpha} L^{1-\alpha}$$

- At any point in time
  - A is given [but may change over time]
  - K is given [but may change over time]
  - L reflects "equilibrium" in labor market
  - Y must therefore be "given" [and AS vertical]

Aggregate supply I



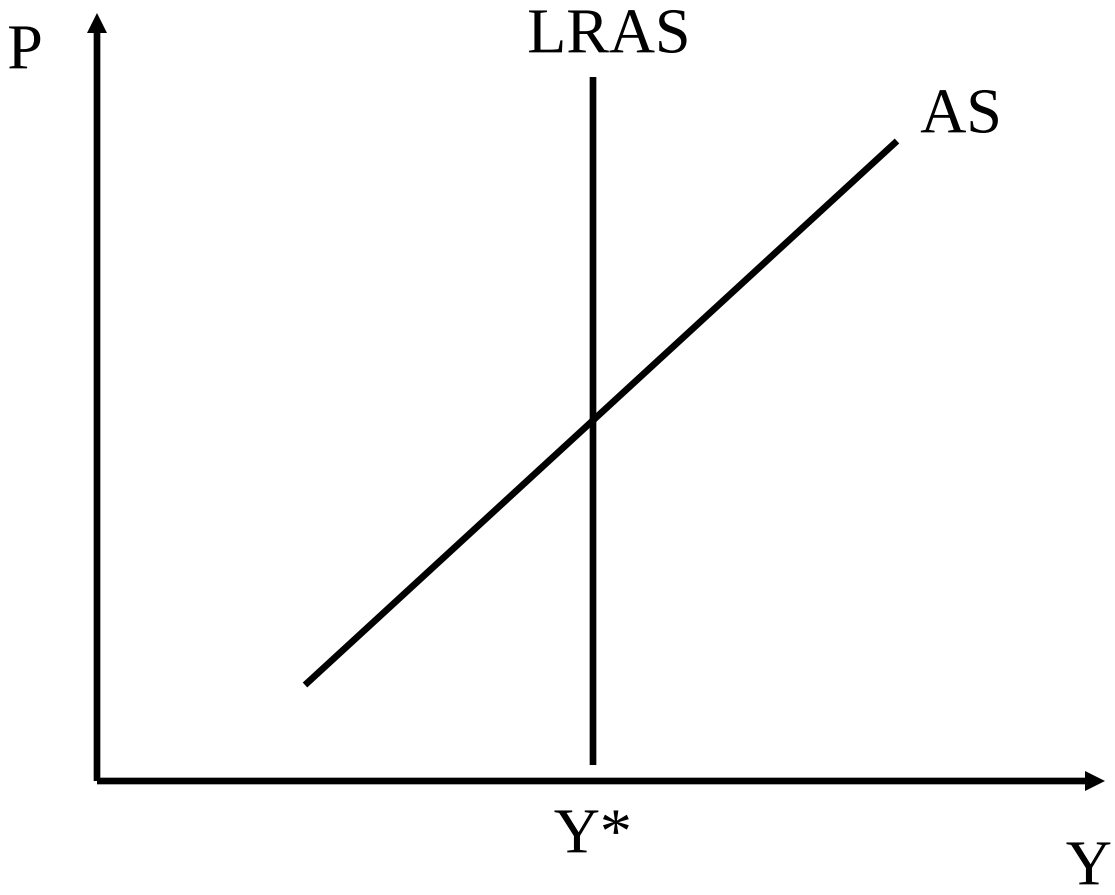
Aggregate supply II

- Short run: sticky prices or wages
- Production function

$$Y = A K^{\alpha} L^{1-\alpha}$$

- At any point in time
  - A, K given
  - Simple version: nominal wage "sticky"
  - Increase in P reduces real wage, so firms hire more people
  - More L implies more Y ⇨ AS curve slopes upward
  - Alternative versions (other prices sticky)
- Wage eventually adjusts, bringing us back to AS*

Aggregate supply II



First Order Conditions Determine…

- Profit maximization

$$\max_{K,L} \ \pi = pAK^{\alpha}L^{1-\alpha} - rK - wL$$

- First order conditions (marg. rev = marg. Cost)

$$\frac{d\pi}{dK} = p\alpha AK^{\alpha-1}L^{1-\alpha} - r = 0$$

$$\frac{d\pi}{dL} = p\left(1-\alpha\right)AK^{\alpha}L^{-\alpha} - w = 0$$

…the demand for inputs

- To find labor demand, use the labor F.O.C

$$p(1-\alpha)AK^{\alpha}L^{-\alpha} = w$$

$$\frac{p}{w}(1-\alpha)AK^{\alpha} = L^{\alpha}$$

- Solve for L to obtain labor demand:

$$L = \{\frac{p}{w}(1-\alpha)A\}^{\frac{1}{\alpha}}K$$

Aggregate supply

- What happens to aggregate supply if we
  - Change A or K?
  - Change price of oil?
- Note: typically both AS and AS* shift

Aggregate demand

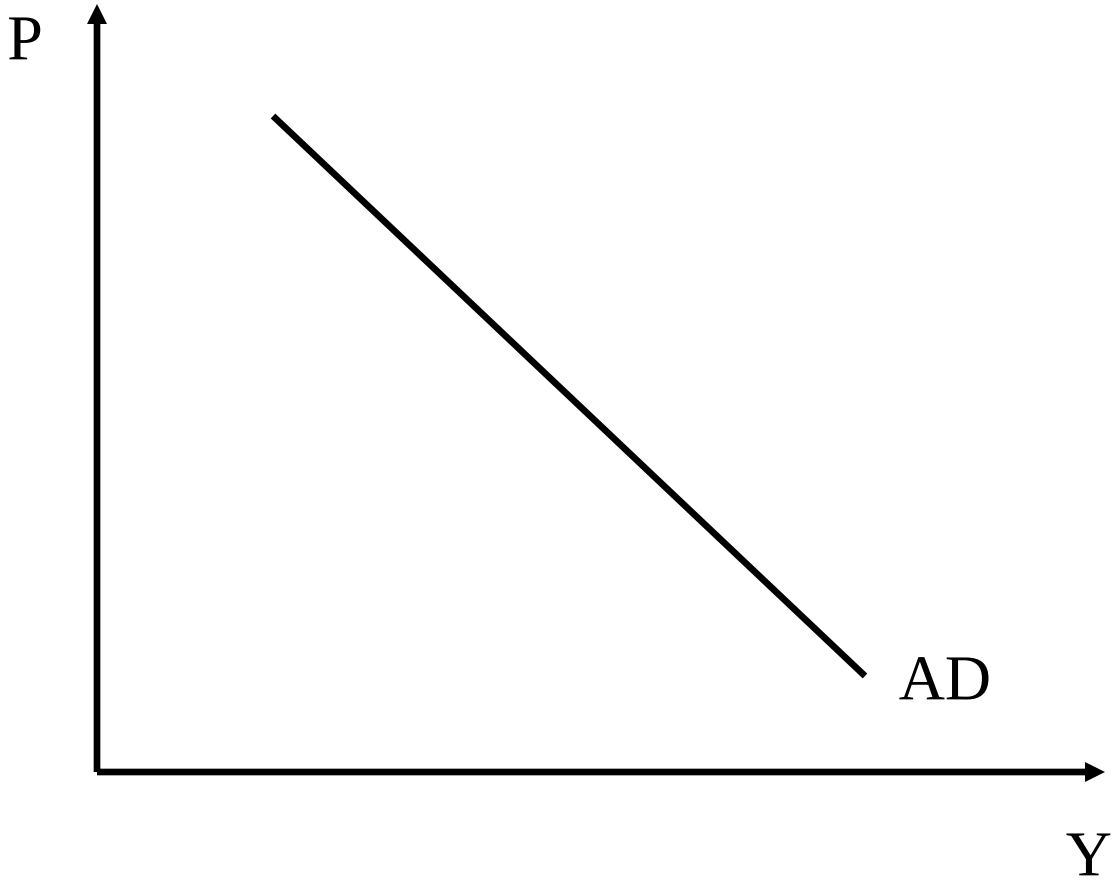
- Basic version
  - Quantity theory: inverse relation between P and Y

$$MV = PY$$

$$P = \frac{MV}{Y}$$

  - Given M and V, an increase in Y results in lower P
  - Note that V need not be fixed (when we study monetary policy next week, V rises with the interest rate, which serves as the policy instrument)

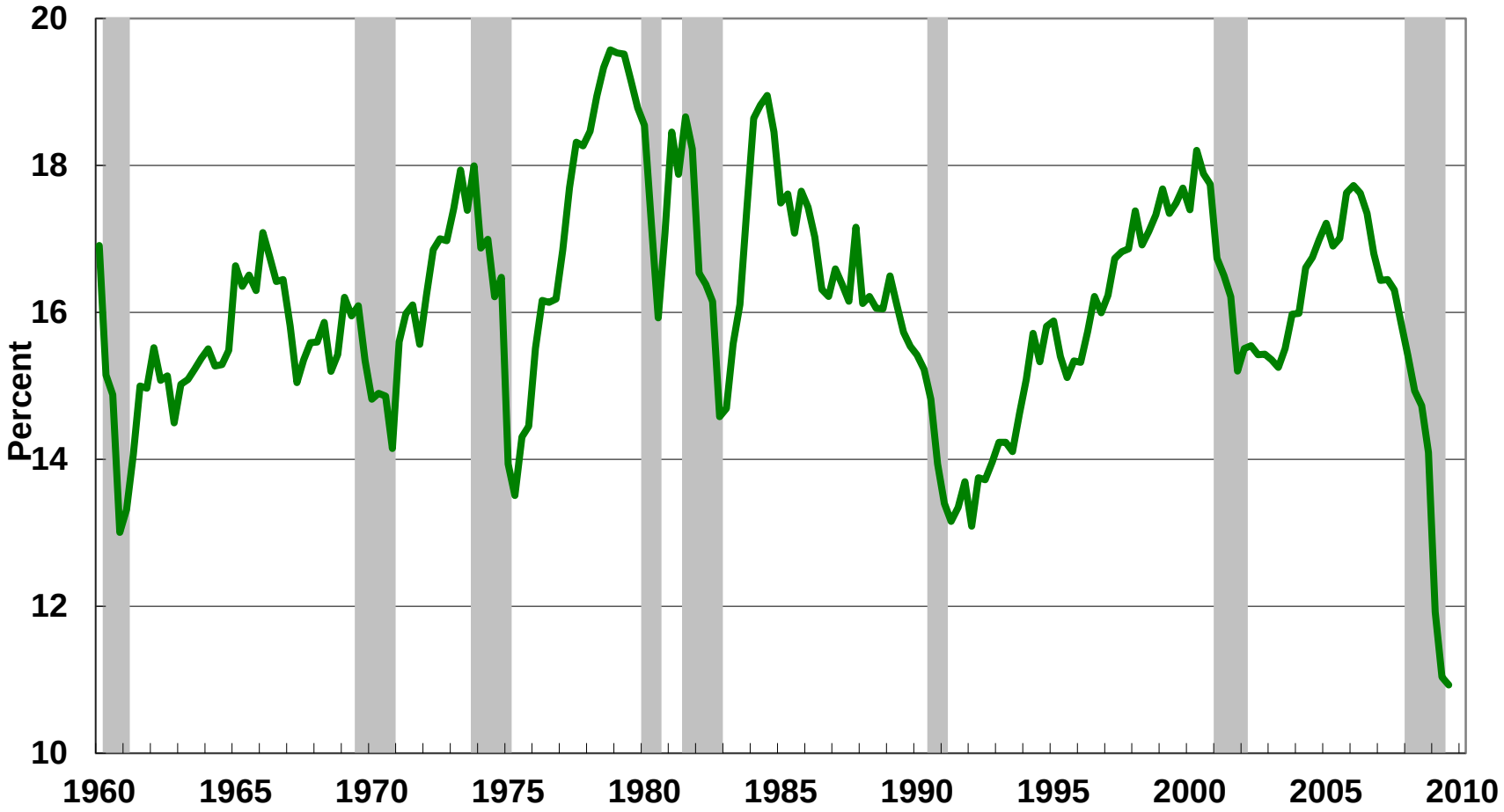
Aggregate demand



Aggregate demand

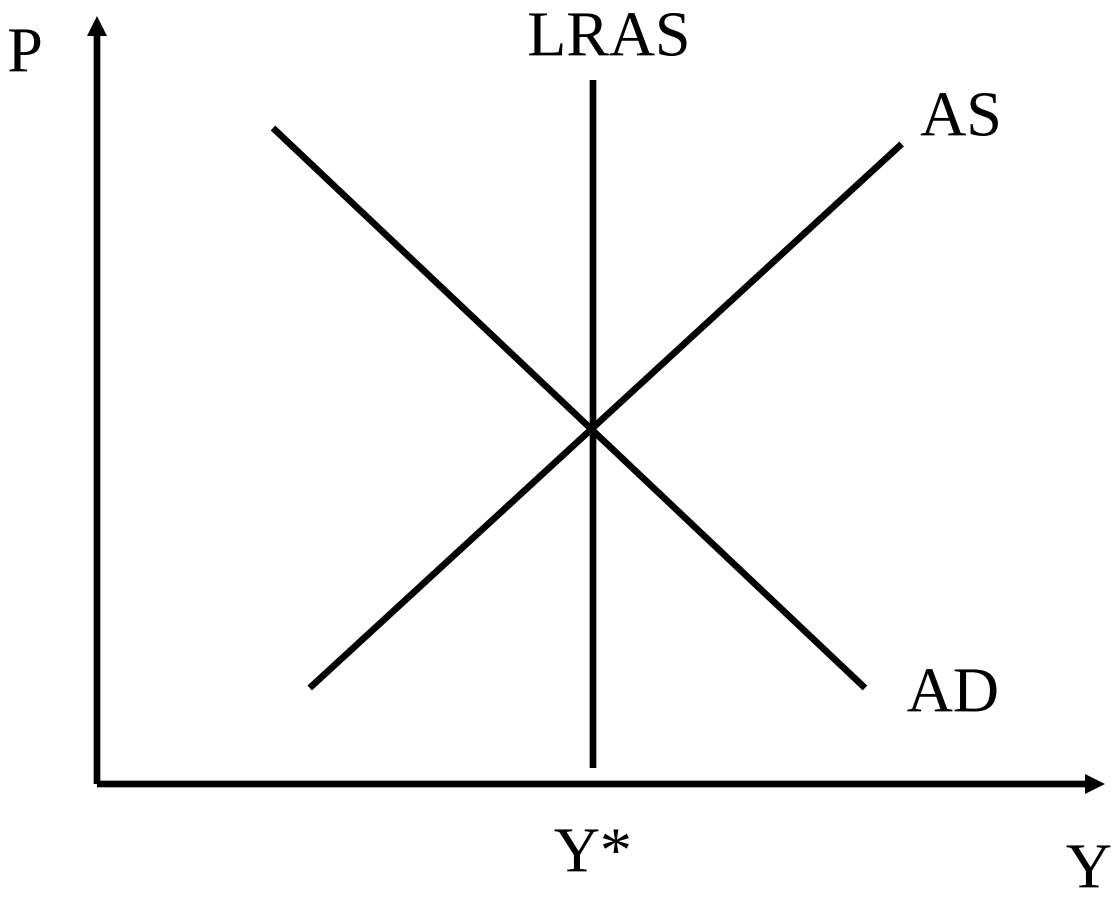
- What happens to aggregate demand if we
  - Change M?
  - Change G?
  - Change consumption or investment demand ("optimism"?)

Investment and Business Cycles

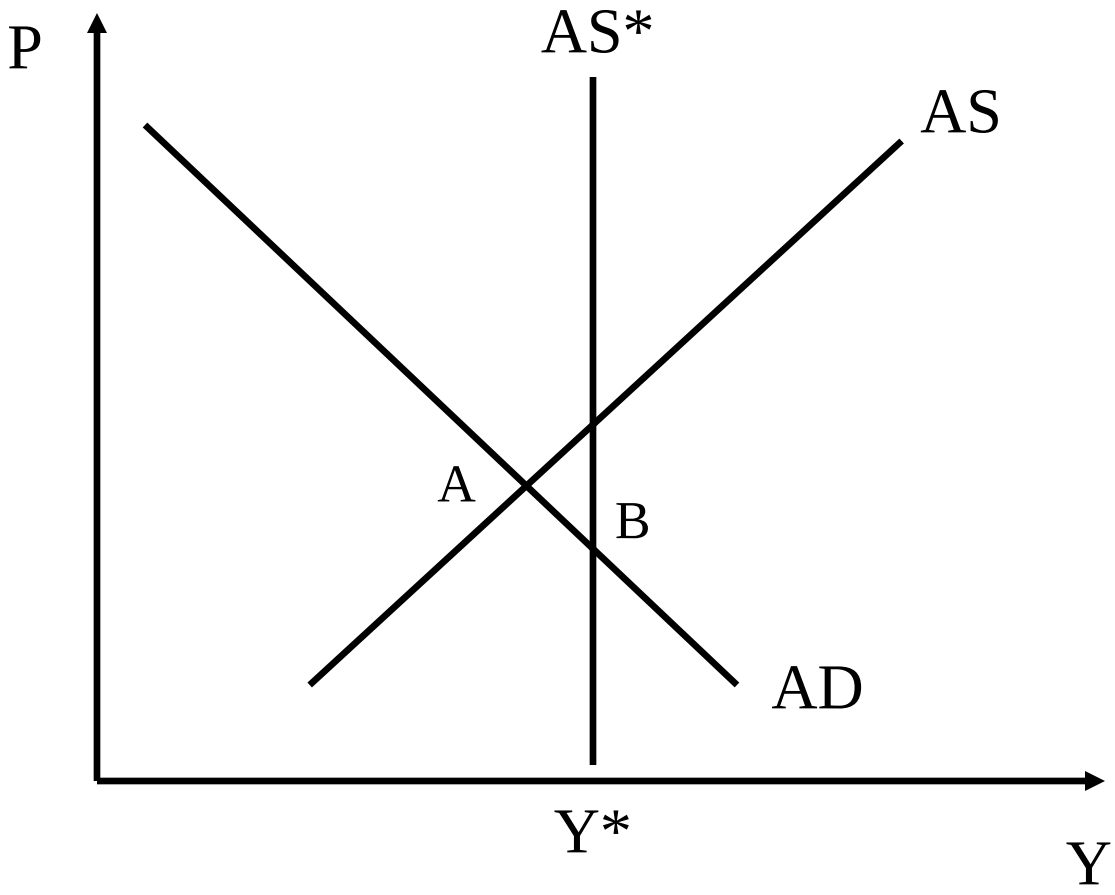


Source: Cecchetti and Schoenholtz, 2010.

Equilibrium



Equilibrium ?



Equilibrium

- Start at A ["short-run equilibrium"]
  - Where AS and AD cross
- Move toward B ["long-run equilibrium"]
  - Why? Because wages adjust, shifting AS down
  - This goes on until AS crosses AS* at B
- What is happening to output? Prices?

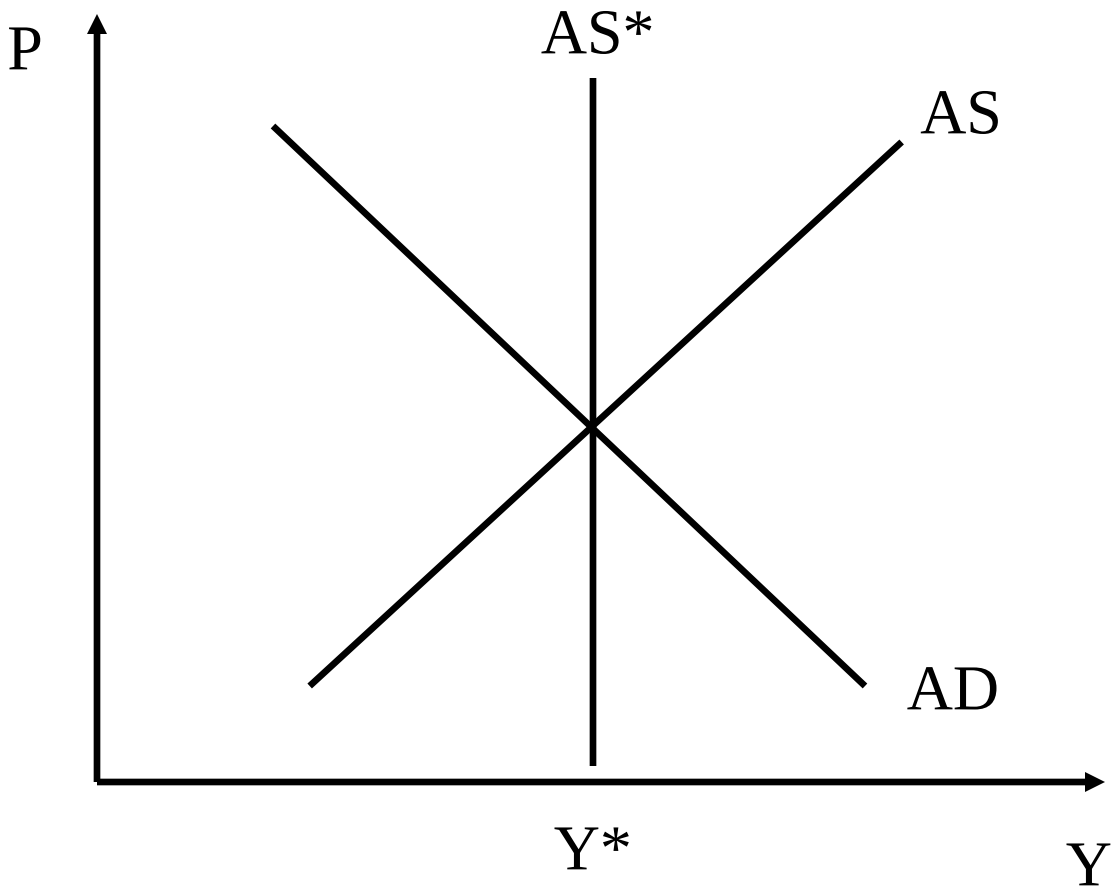
Overview

- AS/AD is a tool for classic analysis
- Goal: keep things simple
- Sort issues into AS and AD bins

Fiscal Stimulus

- Example: increase G
- Does this shift AS or AD?
- Does it raise or lower Y? P?

Fiscal stimulus



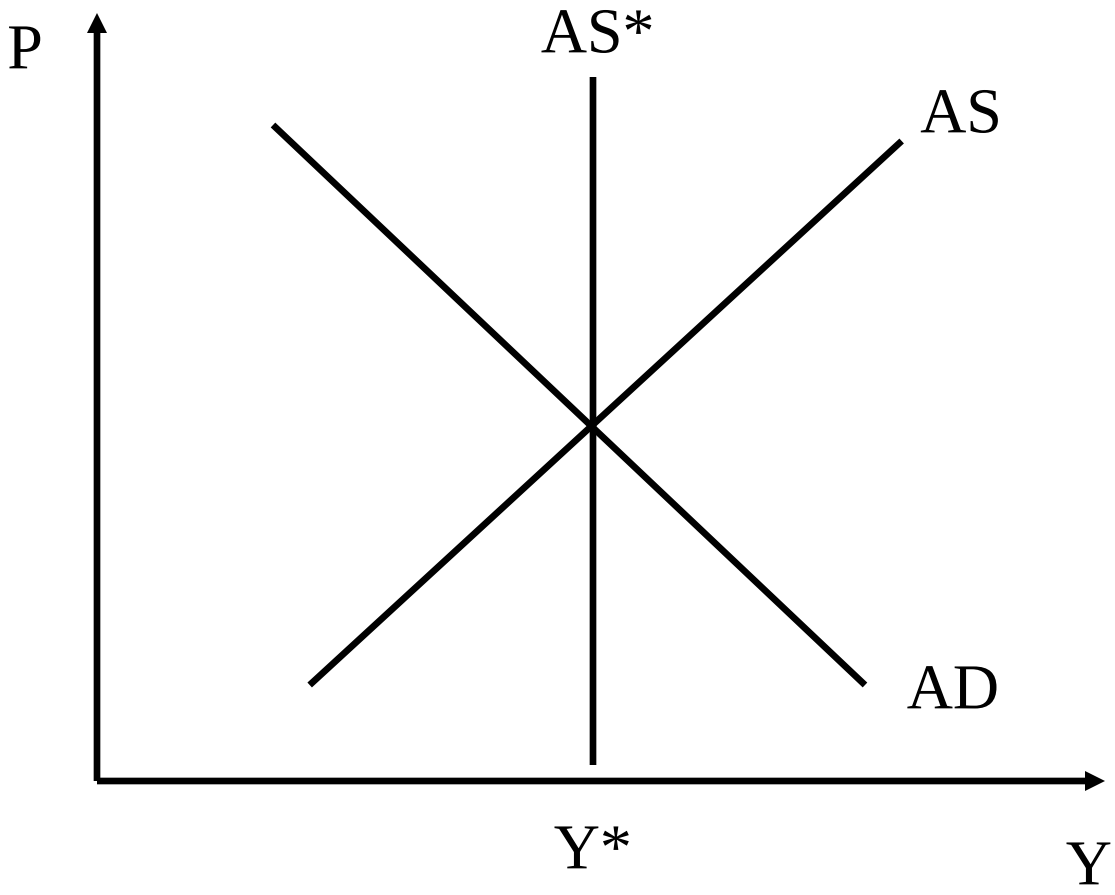
Fiscal stimulus

- Example: increase G
- Does this raise or lower Y? P?
- Impact of increase in "demand"
  - AD shifts right/up
  - Short-run impact: prices up, output up
  - Long-run impact?

Increased productivity

- Example: IT revolution
- Does this shift AS or AD?
- Does it raise or lower Y? P?

Increased productivity



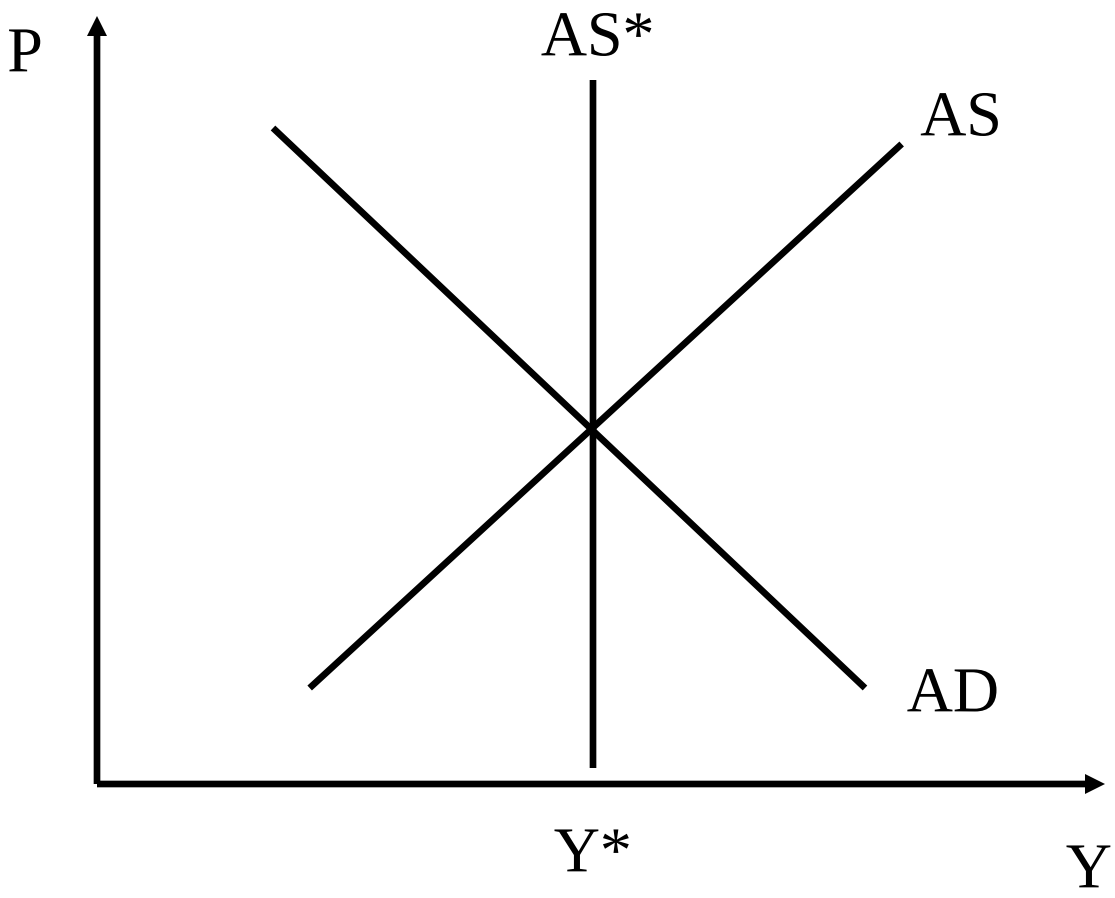
Increased productivity

- Example: IT revolution
- Does this raise or lower Y? P?
- Impact of increase in "supply"
  - AS and AS* shifts right/down
  - Short-run impact: prices down, output up
  - Long-run impact: ditto

More money

- Example: central bank increases M
  - Same as lowering interest rates
- Does this shift AS or AD?
- Does it raise or lower Y? P?

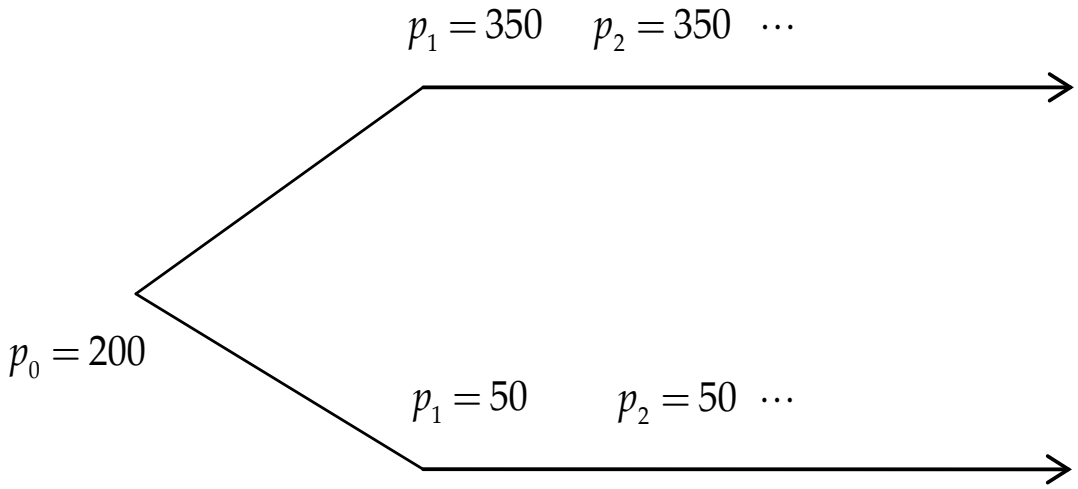
More money



More money

- Example: central bank increases M
- Does this raise or lower Y? P?
- Impact of increase in "demand"
  - AD shifts right/up
  - Short-run impact: prices up, output up
  - Long-run impact? Prices up, output unchanged. [this should remind you of quantity theory]
- This is where/how monetary policy works – more next week

Investment under Uncertainty



Multi-period model
First period: Choice of investing or waiting
Diagram shows returns in good/bad scenarios
Let probability of good scenario (q_H) be 0.5,
so the probability of the bad scenario (q_L=1-q_H) is 0.5.

Valuing the Investment Today

$$NPV = -c + p_0 + \sum_{t=1}^{\infty} \frac{p_t}{(1+r)^t} = -c + p_0 + \sum_{t=1}^{\infty} \frac{1}{(1+r)^t}(q_L p_L + q_H p_H)$$

Where:

c = investment cost = 1100

p_i = return in period i

p_L = bad scenario return = 50

p_H = good scenario return = 350

r = discount rate = 0.1 (10%)

$$NPV = -1100 + 200 + \sum_{t=1}^{\infty} \frac{1}{(1.10)^t}(0.5 \times 50 + 0.5 \times 350) = 1100.$$

Value of Waiting

$$NPV = q_H \times \left[\frac{-c}{1+r} + \sum_{t=1}^{\infty} \frac{p_H}{(1+r)^t} \right] + q_L \times 0$$

So:

$$NPV = 0.5 \times \left[\frac{-1100}{1.1} + \sum_{t=1}^{\infty} \frac{350}{(1.1)^t} \right] + 0.5 \times 0 = 1250.$$

So the value of waiting is 1250 – 1100 = 150.

Waiting avoids the bad scenario!

$$NPV = q_H \times 0 + q_L \times \left[\frac{-P_0}{1+r} + \sum_{t=1}^{\infty} \frac{p_L}{(1+r)^t} \right]$$

$$NPV = 0.5 \times 0 + 0.5 \times \left[\frac{-1100}{1.1} + \sum_{t=1}^{\infty} \frac{50}{(1.1)^t} \right] = -250.$$

Suppose uncertainty rises…

Where:

c = investment cost = 1100
p_i = return in period i
p_L = bad scenario return = 25
p_H = good scenario return = 375
r = discount rate = 0.1 (10%)

$$NPV = 0.5 \times \left[\frac{-1100}{1.1} + \sum_{t=1}^{\infty} \frac{375}{(1.1)^t} \right] + 0.5 \times 0 = 1375.$$

Note that the NPV rises to 1375 from 1250.
It pays more to wait!

Suppose the discount rate falls…

Where: c = investment cost = 1100
p_i = return in period i
p_L = bad scenario return = 50
p_H = good scenario return = 350
r = discount rate = 0.07 (7%)

$$NPV = -1100 + 200 + \sum_{t=1}^{\infty} \frac{1}{(1.07)^t}(0.5 \times 50 + 0.5 \times 350) = 1957.14$$

$$NPV = 0.5 \times 0 + 0.5 \times \left[\frac{-1100}{1.07} + \sum_{t=1}^{\infty} \frac{350}{(1.07)^t} \right] = 1985.98$$

The value of waiting falls from 150 to 28.84 because the opportunity cost of investing falls.

Measures of Dispersion: Variance and Standard Deviation

Variance $$\sigma_x^2 = \sum_{n=1}^{N} q_n (x_n - \overline{x})^2$$

Mean $$\overline{x} = \sum_{n=1}^{N} q_n x_n$$

Standard Deviation $$\sigma_x = \sqrt{\sigma_x^2}$$

A "mean-preserving increase of dispersion" raises the standard deviation but leaves the mean unaltered. This can be viewed as an increase of uncertainty.

Summing Geometric Series

For x > 1

$$X = \sum_{t=0}^{\infty} \left(\frac{1}{x}\right)^t = \frac{x}{x-1}$$

For discounting, let x = 1+r, so…

$$X = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t = \frac{1+r}{r}$$

Dropping the first term…

$$Y = \sum_{t=1}^{\infty} \left(\frac{1}{x}\right)^t = \sum_{t=0}^{\infty} \left(\frac{1}{x}\right)^t - 1 = \frac{x}{x-1} - 1 = \frac{1}{x-1}$$

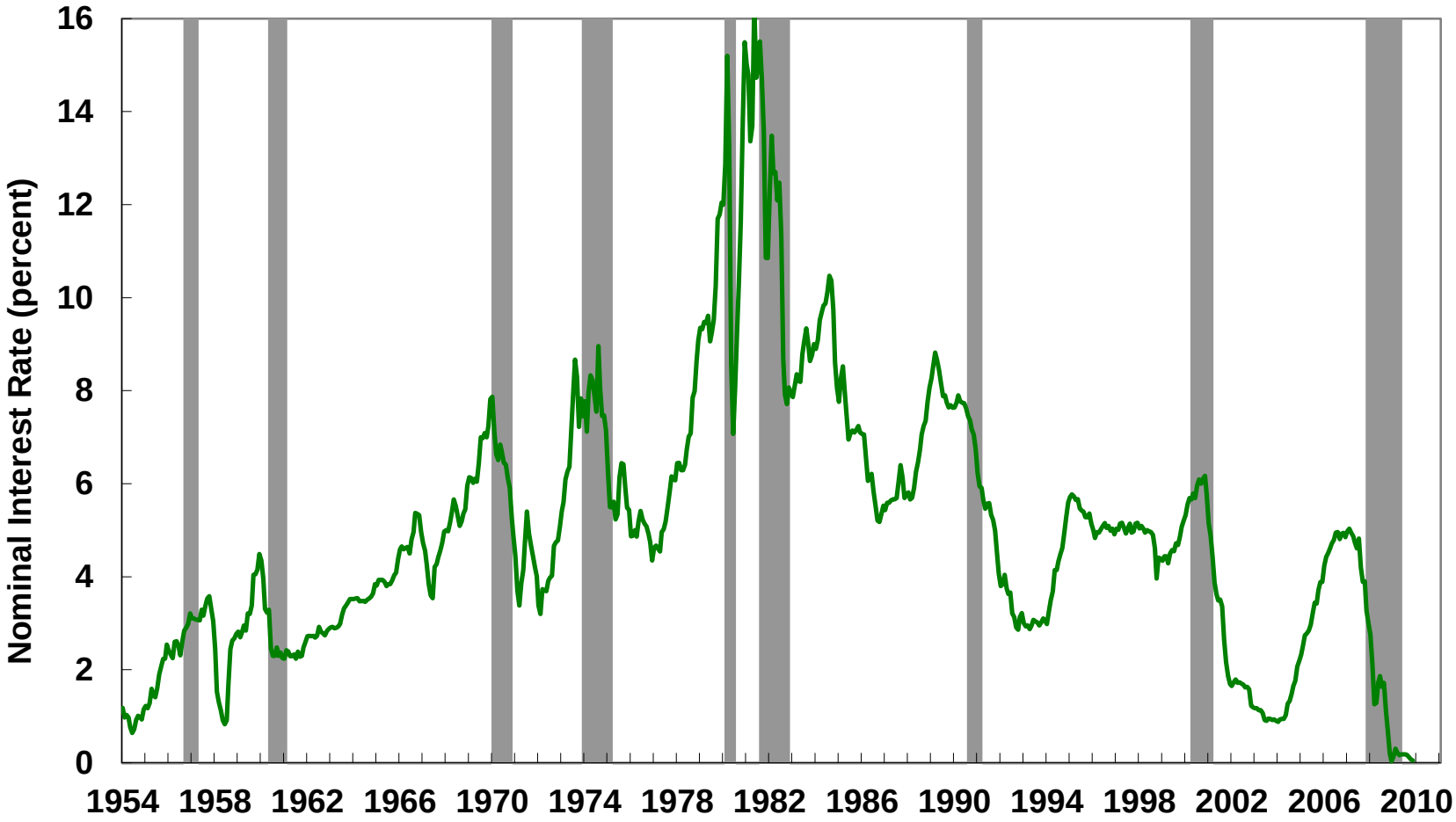
What causes recessions?

Supply vs Demand

Recession	Change of Inflation
1957	3.6 to 3.5 ↓
1960	1.7 to 1.4 ↓
1969	5.7 to 5.4 ↓
1973	7.9 to 10.0 ↑
1980	13.0 to 12.4 ↓
1981	10.3 to 4.4 ↓
1990	4.7 to 4.7 =
2001	2.9 to 1.8 ↓
2007	4.2 to -1.2 ↓

Note: Recessions are dated according to the prior cyclical peak.
Source: Cecchetti and Schoenholtz, 2010.

Interest Rates and Business Cycles

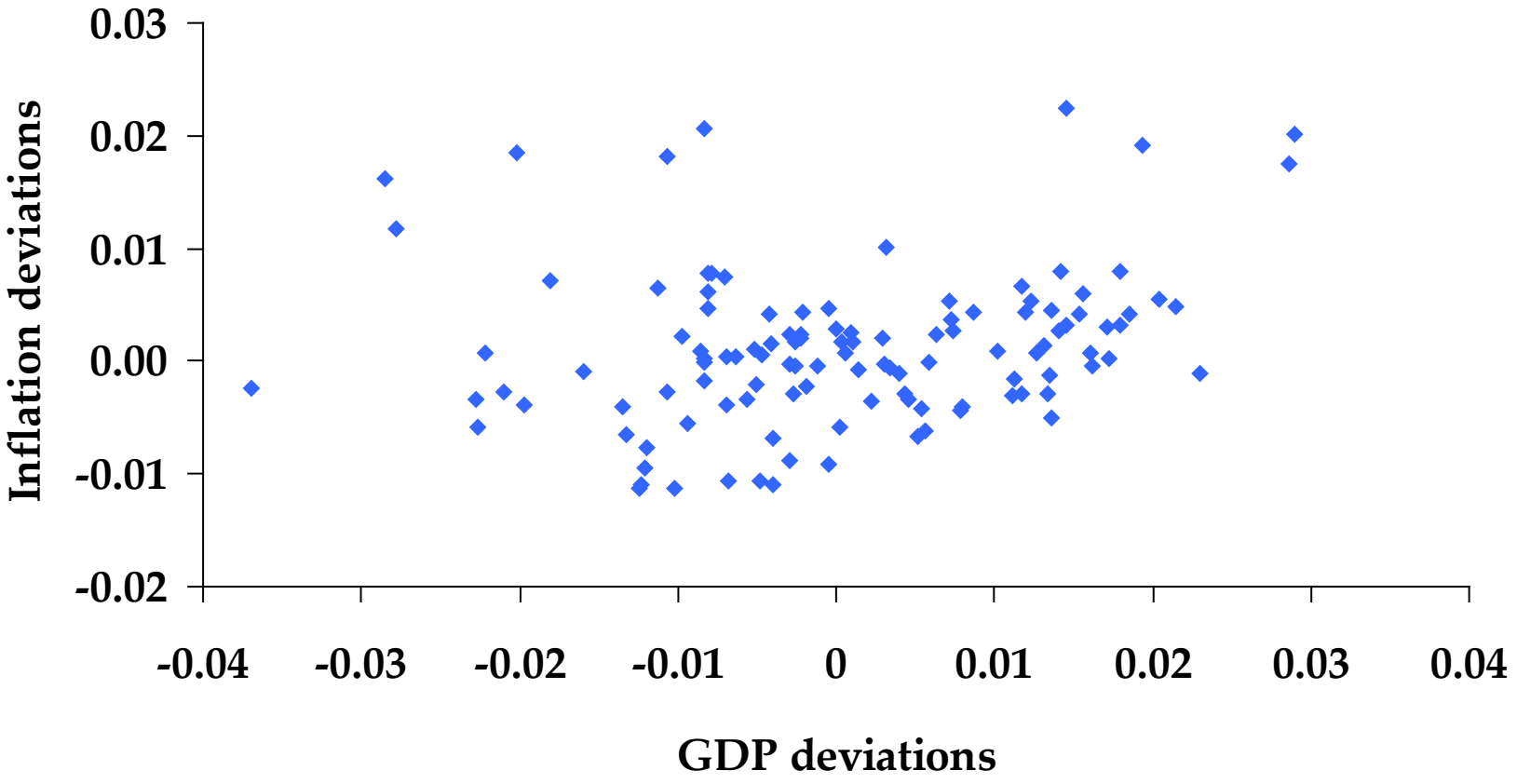


Note: The solid line is the three-month Treasury bill rate. Shaded areas denote NBER recessions.
Source: Cecchetti and Schoenholtz, 2010.

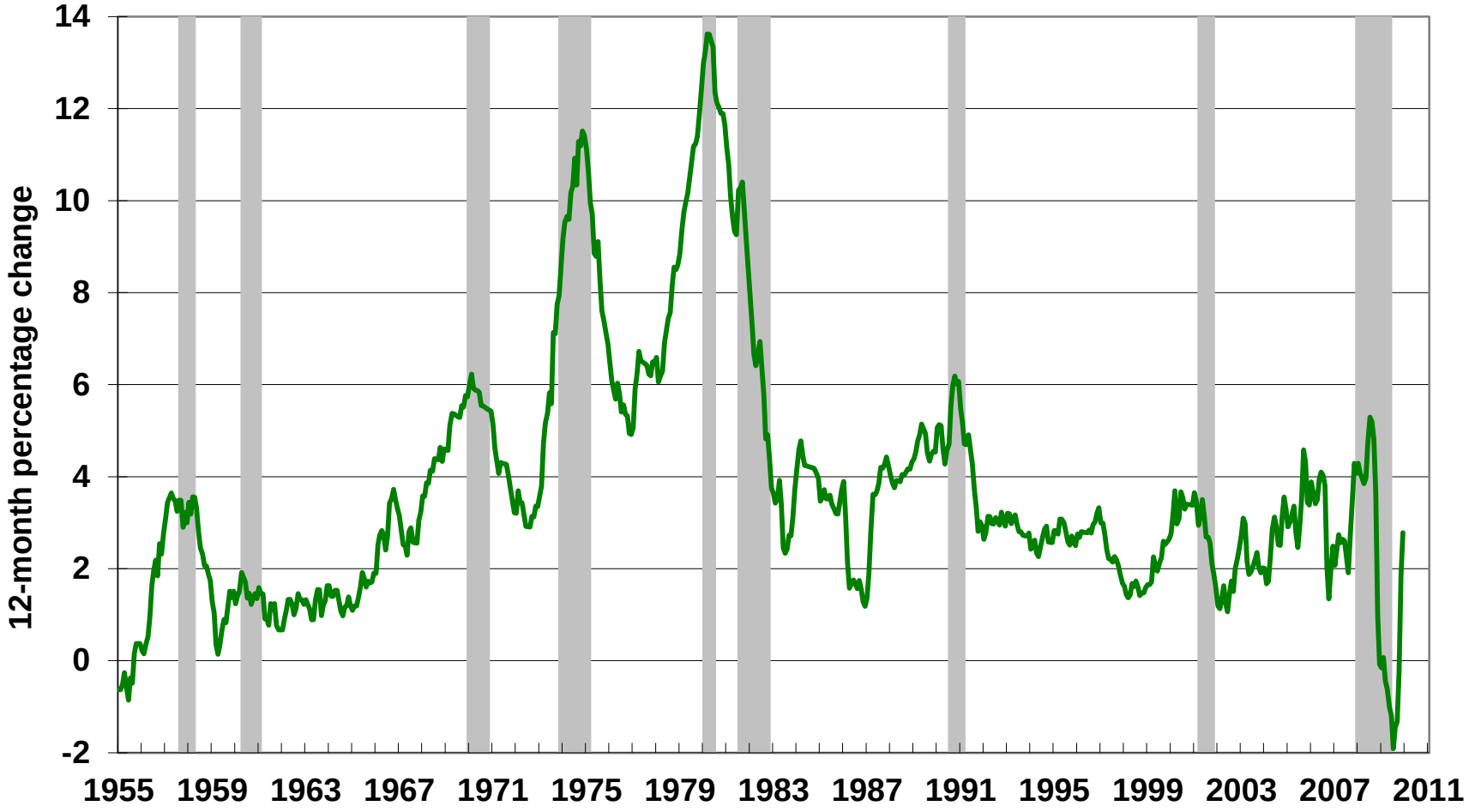
Inflation and growth

- Would you expect to see high growth associated with high inflation? Why or why not?

Inflation


0.03
0.02
0.01
0.00
-0.01
-0.02
Inflation deviations
-0.04
-0.03
-0.02
-0.01
0
0.01
0.02
0.03
0.04
GDP deviations

Inflation and Business Cycles



Note: Inflation measured as annual percent change of CPI. Shaded areas denote NBER recessions.
Source: Cecchetti and Schoenholtz, 2010.

AS/AD summary

- Aggregate supply (producers/sellers) and demand (buyers) is the analytic standard
- In practice, the challenge is to know whether conditions reflect supply or demand

The Global Economy

Quantity Theory of Money

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Quantity theory

- One equation (technology for transactions)

$$M\,V = P\,Y$$

  - M = stock of money in circulation (currency)
  - V = velocity (how often a unit of currency is used in a year)

- In growth rates

$$\gamma_M + \gamma_V = \gamma_P + \gamma_Y$$

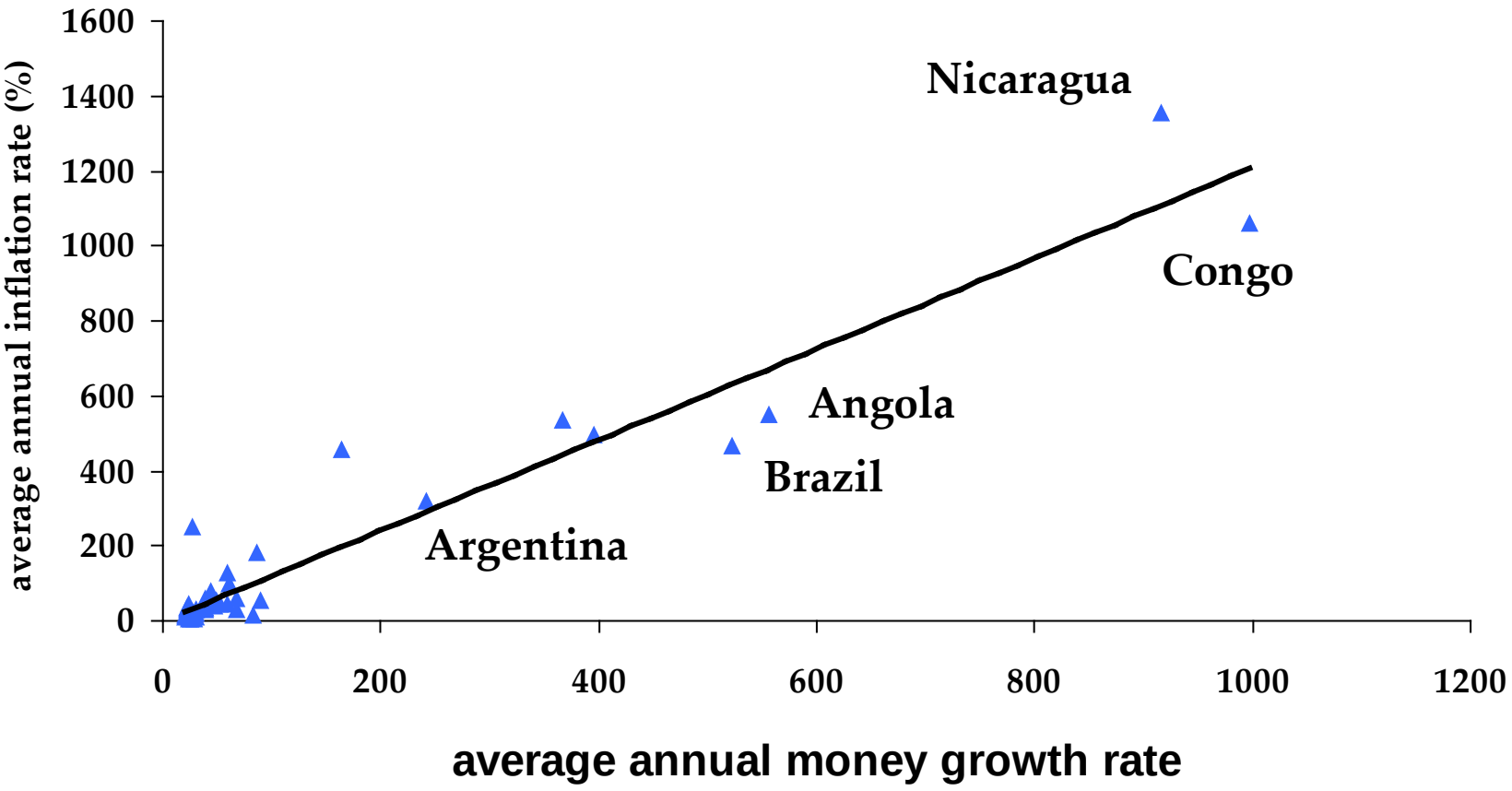
  - γ_M = growth of money supply (think: currency in circulation)
  - γ_V = growth of velocity
  - γ_P = growth of price level (inflation rate)
  - γ_Y = growth of real GDP

Quantity theory

- Two assumptions
  - V is constant
  - Y not affected by changes in M
- One conclusion:
  - money growth causes inflation

$$\gamma_P = \gamma_m - \gamma_Y$$

Rapid money growth



Money supply mechanics

- The treasury issues debt: bills, bonds, etc
- Central bank manages the money supply
- Balance sheets for
  - Treasury
  - Central bank
  - Private agents: households and firms

Open market operations

Treasury

Assets		Liabilities	
		Bills	200

Central bank

Assets		Liabilities	
Bills	20	Money	20

Households and firms

Assets		Liabilities	
Money	20		
Bonds	180		

- Where does treasury debt come from?
- How does the central bank increase money supply?

Putting quantity theory to work

- Hyperinflations

Selected Hyperinflations

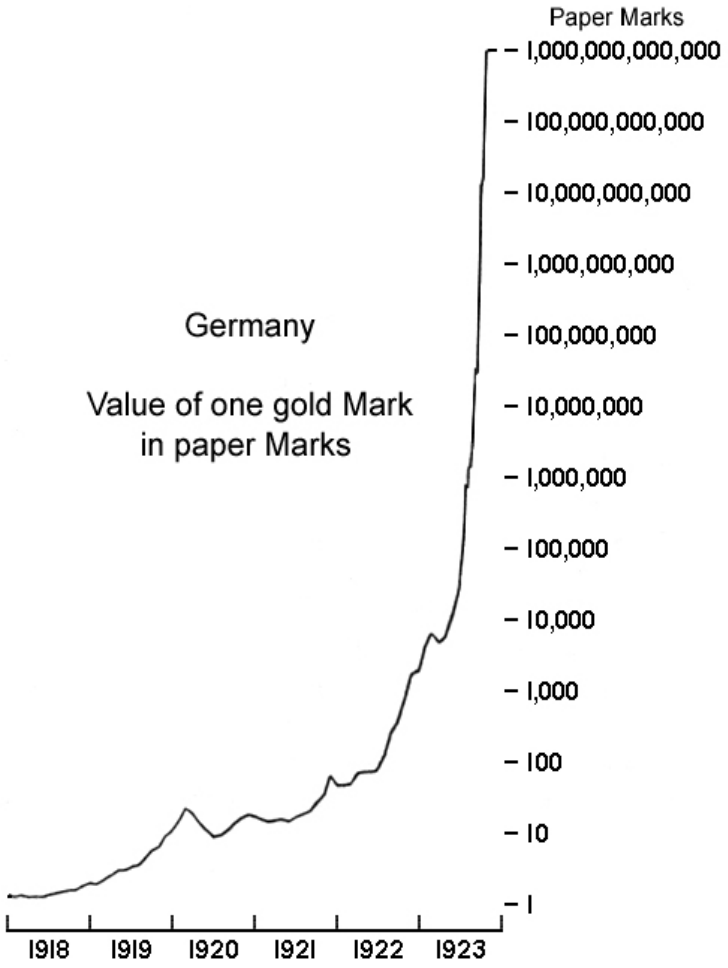
Nation	Period	Cumulative Inflation Rate
USA	1777-1780	2702
Germany	1919-1923	0.5×10^{12}
Greece	1941-1944	1.6×10^{11}
Hungary	1945-1946	1.3×10^{24}
Nicaragua	1986-1991	1.2×10^{10}
Yugoslavia	1993-1994	1.6×10^{9}
Zimbabwe	2001-2008	8.53×10^{23}

Source: Cowen and Tabarrok, 2010.

German Hyperinflation

- Germany paid for WWI by issuing debt and printing money. Rationing concealed the underlying inflation until after the war.
- Postwar political instability
- Versailles reparations impose a new burden of government spending (greater than 5% of GDP) with limited tax opportunities. Allies seek payment in kind (coal).
- 1923 occupation of Ruhr leads to "passive resistance" and government transfer payments

The Acceleration Phase



Life in a Hyperinflation

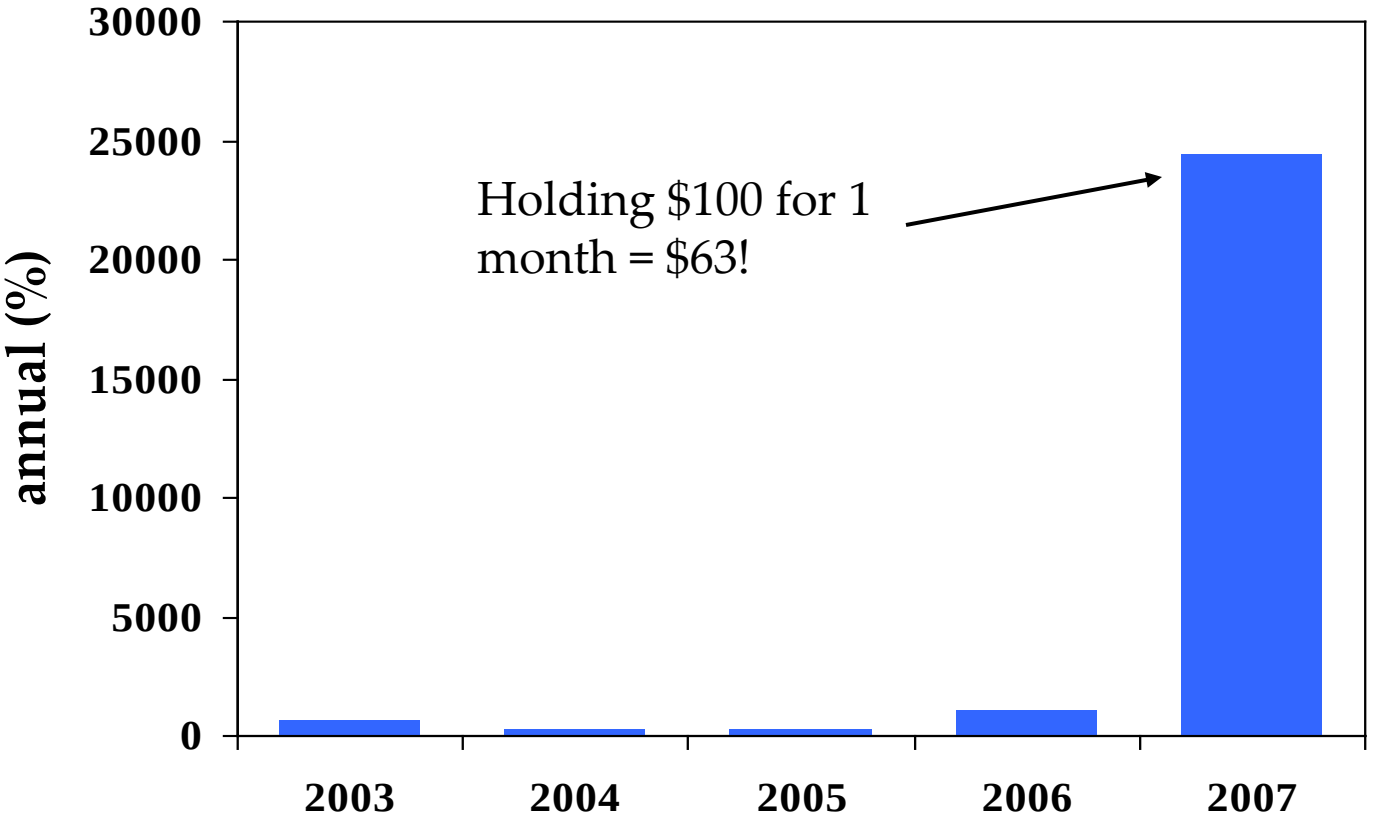
Inflation: Zum Abholen der riesigen Mengen Papiergeld waren Reisekörbe nötig

Why Hyperinflation in Zimbabwe?

"Governments and counterfeiters alone can pay their bills by printing money. […] Mugabe pushed the printing presses to breakneck speed. Whenever a bill came due or soldiers needed paying it was not problem – just print more money. In May 2006, for example, the government announced plans to print 60 trillion Zimbabwean dollars to finance a 300% pay increase for soldiers. Ironically, the payment was delayed because Zimbabwe didn't have enough U.S. dollars to buy ink and paper."

Cowen and Tabarrok, 2010.

Inflation in Zimbabwe



Source: IFS.

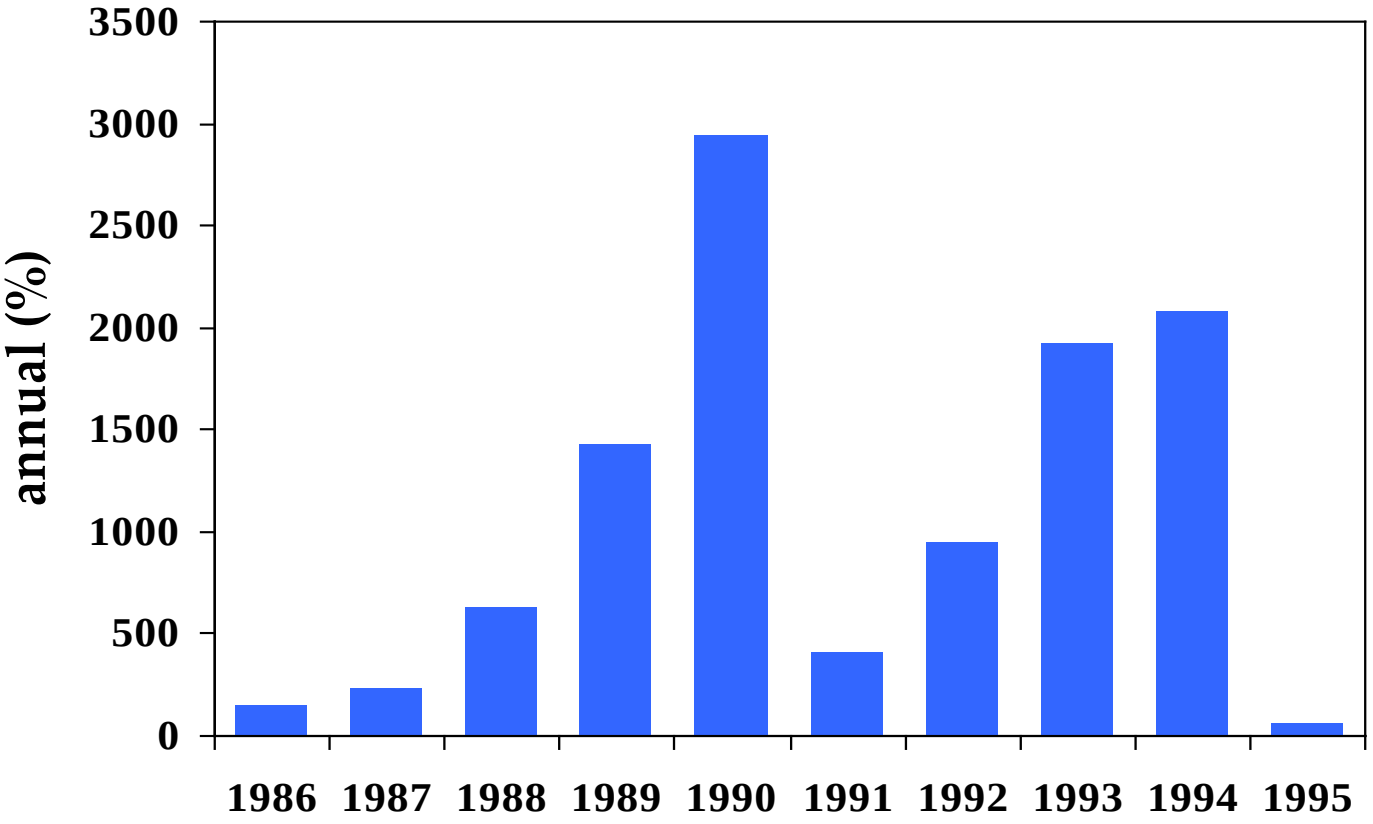
Zimbabwe

- Dec 06: inflation over 1000 percent
- Feb 07: inflation ruled “illegal”
- Oct 08: inflation over 200 million percent (!)
- Jan 09: transactions allowed in foreign currencies
  - Soldiers and teachers to be paid in USD
- Feb 09: 12 zeros knocked off currency
- April 09: currency is suspended all trades made in foreign currency

Endgame


100 000 000 000 000 RESERVE BANK OF ZIMBABWE
100 000 000 000 000
ONE HUNDRED
TRILLION
DOLLARS
100 000 000 000 000
AA0007512
AA0007512

Inflation in Brazil



Source: EIU database.

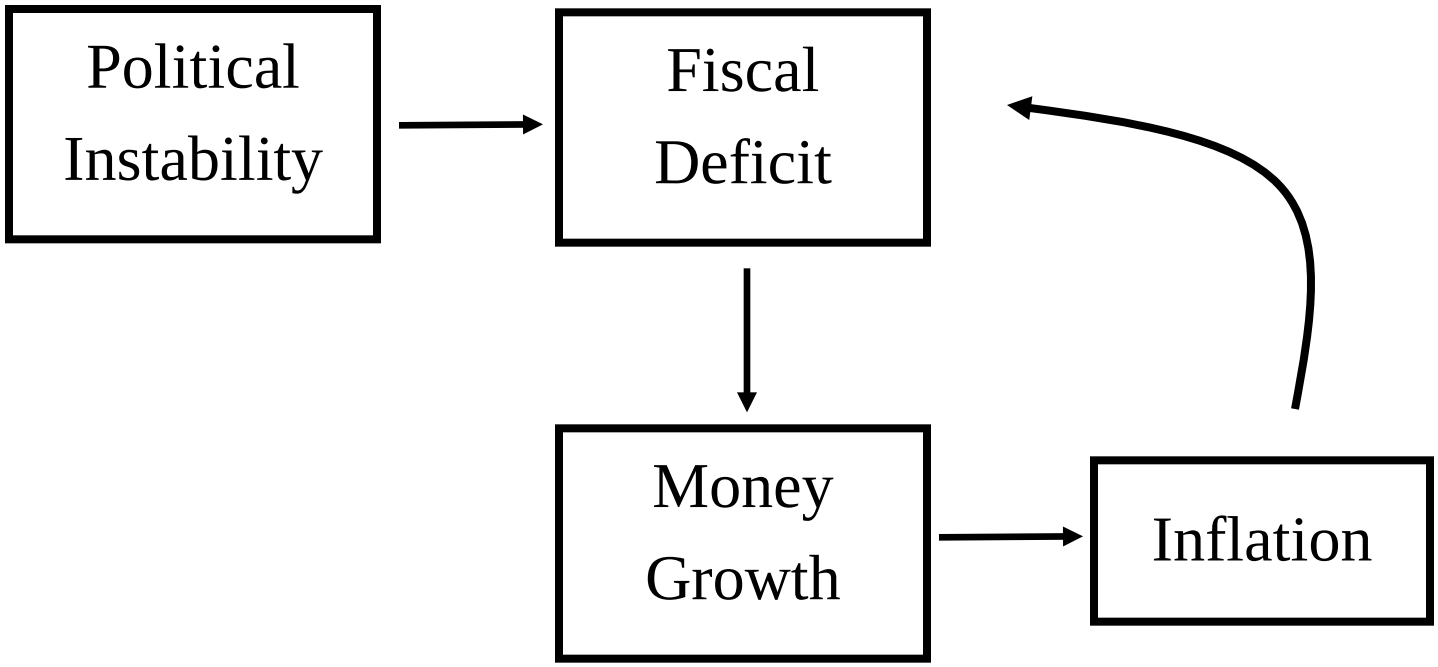
Hyperinflation

- Weak institutions
  - Poor fiscal discipline
  - Non-independent central bank
  - Postwar stresses as a common factor
- Government issues debt no one wants
- Central bank monetizes debt
  - Prints money, buys debt
- Inflation makes government finances worse
  - Expenses happen now, revenues come later
  - Issue more debt, central bank monetizes it again, repeat

How do hyperinflations depress economies?

- Velocity accelerates: "hot potato"
- Households and firms waste resources economizing on money
- Late stages of hyperinflations, the real value of money can plunge: insufficient liquidity!
- Households and firms may be forced into inefficient modes of exchange (e.g. barter) or switch to foreign currency that is in inadequate supply

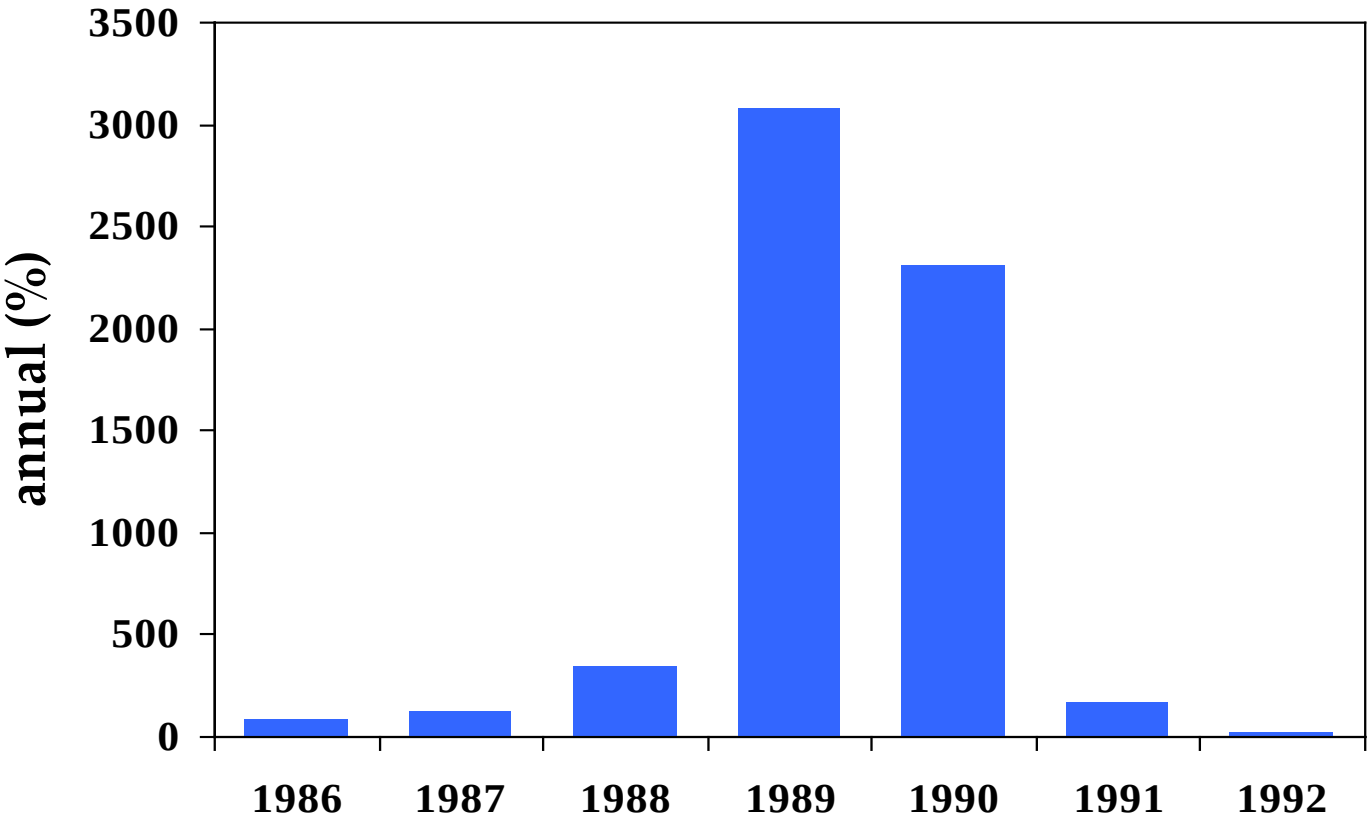
Quantity theory and hyperinflation



Ending hyperinflation

- Ending a hyperinflation requires restoring confidence in the central bank
  - Easier said than done
- Fix the local currency to something
  - Gold?
  - Foreign currency (import credibility)

Inflation in Argentina



Source: EIU database.

Purchasing power during hyperinflation

- Suppose annual inflation rate is 3000%, compounded daily (0.95% daily)
- Start with 100 Pesos on January 1
- 100 Pesos is worth
  - January 7: 95 Pesos
  - January 30: 76 Pesos
  - March 1: 57 Pesos
  - June 1: 24 Pesos
  - December 31: 3 Pesos

Ending inflation in Argentina

- 1975-1990: hyperinflation in Argentina
  - Large fiscal deficits (central and local gov't)
  - Difficult to borrow externally
  - Financed by central bank printing money

Convertibility plan

- March 1991: Convertibility
  - 1 USD = 1 New Peso (or 10,000 Australes)
  - Rate can only be changed by legislation
  - Central bank holds 1 USD for every New Peso in circulation
  - USD made legal tender in Argentina
  - Other reforms include privatization of government owned enterprises

Post 1991

- Hyperinflation ended
- Central bank left to manage currency board
- Government spending not tamed
  - Privatization proceeds fund deficits
  - Eventually run out
  - Interest rates rising, difficult to increase the money supply
- Crisis anew
  - Central bank losing dollar reserves
  - Convert dollar deposits into Pesos
  - Abandon peg in January 2002

Inflation takeaways

- In the long run, inflation comes from money growth
- In big inflations, money growth typically comes from fiscal deficits …
- … and fiscal deficits reflect political chaos
- Solution
  - central bank independence (a solution: peg to a better currency)
  - fiscal discipline
  - Less chaos (easier said than done)
- Modest inflation is a different beast