IS-LM Equilibrium

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Objectives

In this section you will learn how to

1. put IS and LM together and derive the equilibrium;
2. determine the effects of shocks and policies on equilibrium output and interest rate

Model Summary

- Endogenous objects: Y, i
- Exogenous objects: $\bar{I}, c_0, G, T$ $\longrightarrow \bar{z}$
  - also M, which we take as controlled by CB for now
- Equations:
  - IS: $Y = C(Y - T) + I(Y, i) + G$
  - LM: $M/P = YL(i)$

$M = \$Y \cdot L(i)$

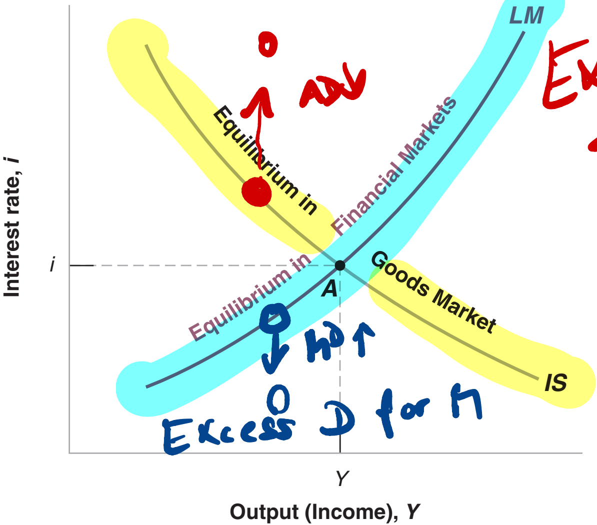
$\downarrow$

nominal

$\$Y = P \cdot Y$

IS-LM Graph

$Y = C(Y-T) + I(Y,i) + G$

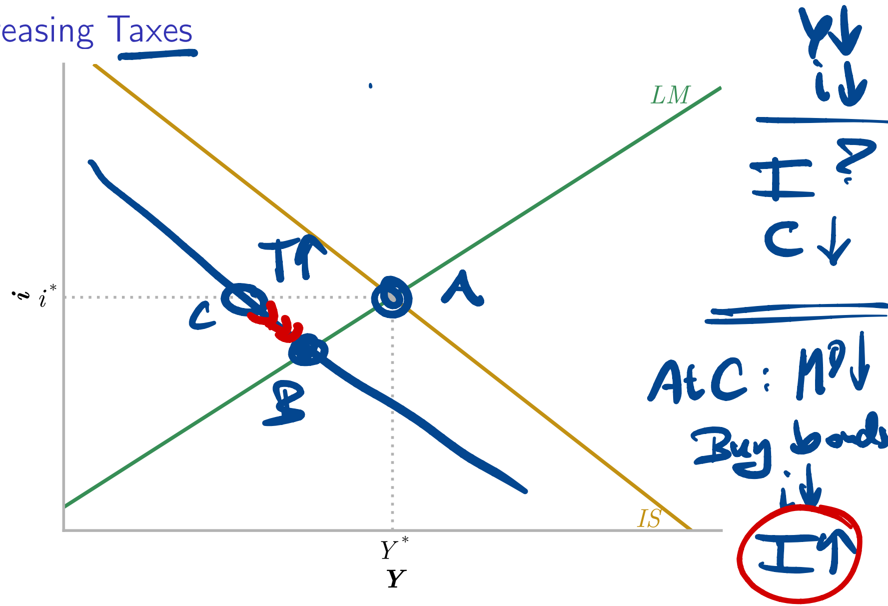


Excess supply of goods

What happens in each market in each quadrant?

Applications

Increasing Taxes



IS: $Y = C(Y-T) + I(Y,i) + G$. LM: $M/P = YL(i)$. The shock: $T\uparrow$

Interactive IS-LM Model

Taxes and Investment

- A common argument:
  - higher taxes reduce disposable income and saving
  - saving = investment
  - **investment must fall**
- Another common argument:
  - higher taxes reduce the government deficit
  - more money available for investment
  - **investment rises**
- Which argument is right?

What happens in the model?

Identity: $I = S^P + S^G$

Public saving: $S^G = T - G$

$S^G \uparrow$

- rises by the change in T
- assuming G is unchanged!

Private saving: $S^P = Y - T - C(Y - T)$

- $(Y - T) \downarrow$
- $MPC < 1 \implies C \downarrow$ by less than $Y - T$
- $S^P \downarrow$

Net change in S is ambiguous.

Increasing Taxes

What is missing in our analysis?

- The **government budget constraint**.

The government cannot raise taxes without changing another policy.

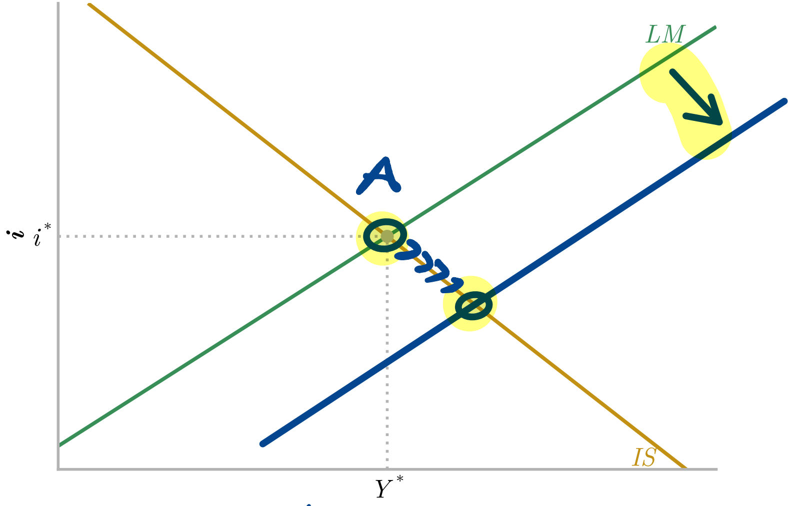
The revenue has to go somewhere.

- Either $G\uparrow$ or public debt $\downarrow$.

A limitation of the IS/LM model.

Monetary Expansion

$Y\uparrow$
$i\downarrow$



Transmission $i\downarrow \rightarrow I\uparrow \rightarrow Y\uparrow$

IS: $Y = C(Y-T) + I(Y,i) + G$. LM: $M/P = YL(i)$. The shock: $M\uparrow$

Monetary Transmission

The link between monetary and real sector is the interest rate.

$M \uparrow \Longrightarrow i \downarrow \Longrightarrow I \uparrow$

What happens when investment is very interest inelastic?

- $I = \bar{I} + b_1 Y - b_2 i$
- b_2 is small

IS: $Y(1 - b_1 - c_1) = \bar{Z} - b_2 i$

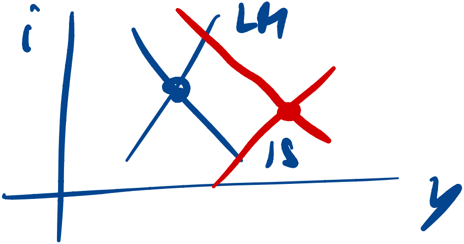
Slope $= -\dfrac{1 - b_1 - c_1}{b_2}$

Policy Mix

The government can, in principle, move Y and i independently.

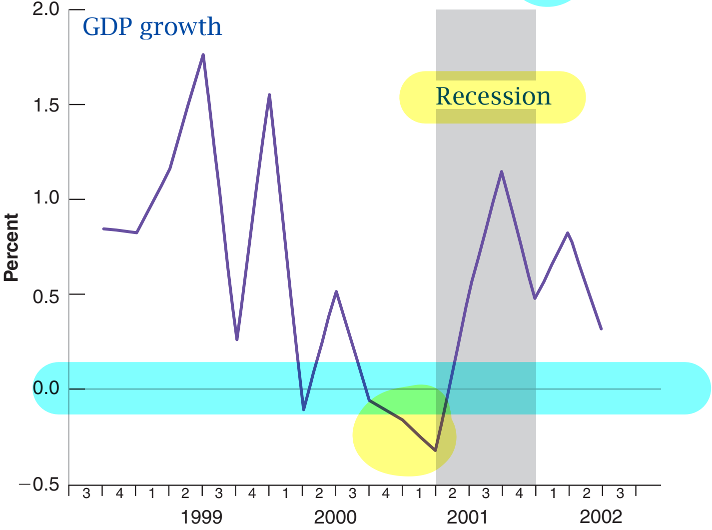
- Monetary expansion: $Y \uparrow, i \downarrow$
- Fiscal expansion: $Y \uparrow, i \uparrow$
- Combination: $Y \uparrow, i$ unchanged

In a typical recession, monetary and fiscal policies expand.

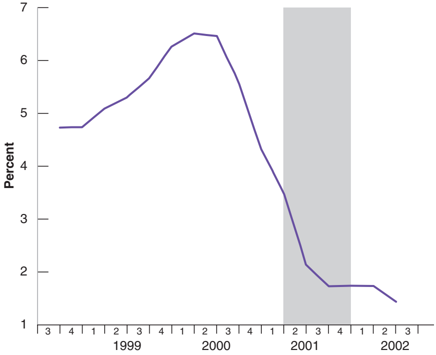


Example: 2001 Recession

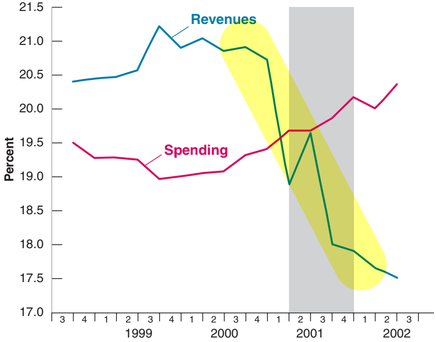
The shock: bursting of the tech bubble $\Longrightarrow I\downarrow$



Policy Responses



Federal funds rate



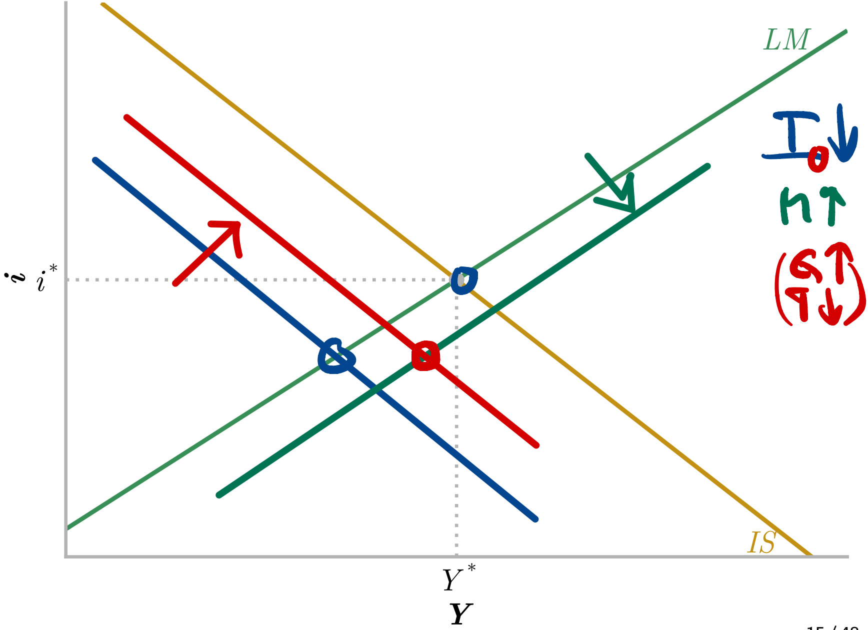
Government spending / revenue

Note that spending moves very slowly.

Revenues drop rapidly (automatic stabilizer).

$Y = C + I + G$

Analysis of the 2001 Recession



How Effective are Tax Cuts?

How Effective are Tax Cuts?

Does cutting taxes have a big impact on demand?

How does the answer depend on the MPC?

- MPC = marginal propensity to consume

The answer depends on

- how big is the stimulus (change in demand)?
- how big is amplification?

Stimulus from tax cuts

IS: $Y(1-b_1-c_1) = \bar{Z} + -b_2 i$

with $\bar{Z} = C_0 + I_0 + G - c_1 T$

Stimulus = $c_1 \times \Delta T$

- high $MPC \implies$ large stimulus (intuitive)

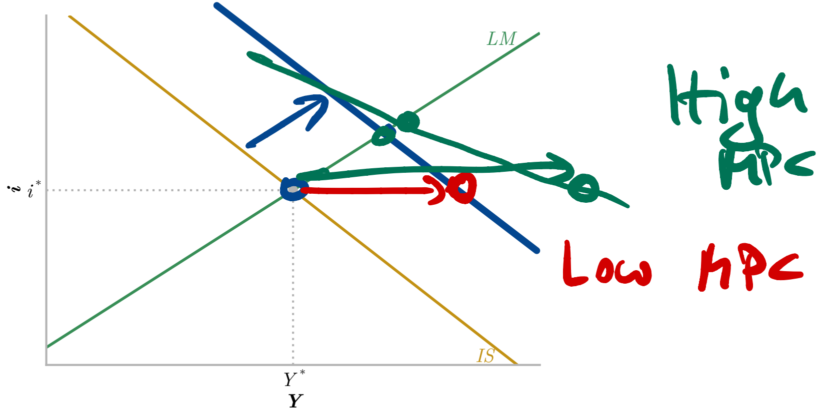
How much does IS shift right?

- $\Delta Y \times (1-b_1-c_1) = -c_1 \times \Delta T$ (holding i fixed)
- Right shift: $\Delta Y = -\frac{c_1}{1-b_1-c_1} \Delta T$
- High $MPC \implies$ large right shift.

Amplification

For a given shift of IS, how much does equilibrium Y rise?

The answer depends on the slope of IS (and LM)



Slope of IS

Solve for the interest rate:

$$i = \frac{\bar{Z} - c_1 T - (1 - b_1 - c_1)Y}{b_2} \tag{1}$$

Slope of IS: $-(1 - b_1 - c_1)/b_2$

High MPC c_1 implies

- flat IS
- small change in Y for given shift in IS

Intuition?

How big is the change in Y?

High MPC means

- big right shift of IS
- lots of crowding out (movement along IS)

Is the answer ambiguous?

- the question being: does a high MPC make tax cuts more or less effective?

Second attempt

Let's look at the vertical shift of IS:

$$i = \frac{\bar{Z} - (1 - b_1 - c_1)Y}{b_2} \tag{2}$$

Holding Y constant, the vertical shift is:

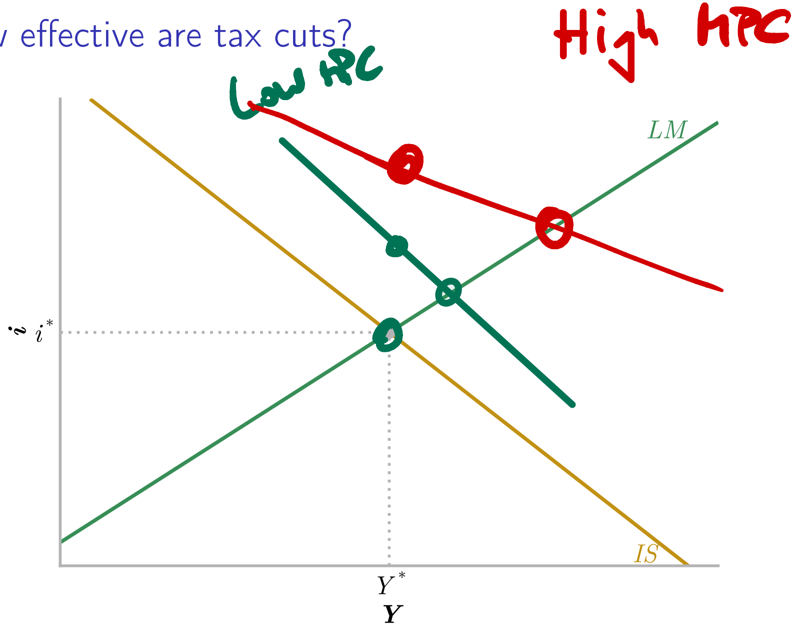
$$\Delta i = -\frac{c_1}{b_2} \times \Delta T = \frac{\Delta \bar{Z}}{b_2} \tag{3}$$

High MPC implies:

- large vertical shift
- flat IS

Now what is the total effect on Y?

How effective are tax cuts?



How Large is the MPC?

The effectiveness of tax cuts depends critically on the MPC.

How big is the MPC in the data?

> *Empirical estimates of the aggregate marginal propensity to consume (MPC) in the U.S. range from 0.05 to 0.9 depending on the event and sample of the study.*
> *– Background: Marginal Propensities to Consume in the 2021 Economy —{} Penn Wharton Budget Model*

That's a pretty wide range!

Why so wide?

How Large is the MPC?

Key point

There is no one MPC.
Each person has their own MPC.
Each stimulus / shock has its own MPC.

A simple model of consumption / saving helps to understand this.

A Simple Model

Assumptions:

- Households like smooth consumption
- They can borrow and lend freely

Budget constraint:

present value of consumption = present value of income + initial wealth

Why?

- We derive this later for the government
- The same logic applies to any household who can borrow and save

If you want to see the details in a more general model, see the slides from previous years.

Live for T periods

Utility $\displaystyle\sum_{t=1}^{T} u(c_t)$ $\quad u'(c)>0$, $\quad u''(c)<0$

Budget constraint $\displaystyle\sum_{t=1}^{T} p_t c_t = y$

$$\mathcal{L} = \underbrace{\sum_{t=1}^{T} u(c_t)}_{\text{objective}} + \lambda \underbrace{\left[y - \sum_t p_t c_t \right]}_{\text{constraint}}$$

multiplier

FOC $\dfrac{\partial \mathcal{L}}{\partial c_t} = 0$

$$\frac{\partial \mathcal{L}}{\partial c_t} = u'(c_t) - \lambda p = 0$$

$$\boxed{\lambda = \frac{u'(c_t)}{p_t}}$$

$$u'(c_t) = \lambda p = \text{same for all } t$$

A Simple Model

Households live for T periods.

Exogenous income stream y_t

Simplifying assumption: households want **constant** consumption

- $c_t = \bar{c}$
- more general: smooth consumption, but the implications are the same

Simplifying assumption: the real interest rate is zero

- present value is simply sum of expenditures
- non-zero interest rates change the math, but not the message

Marginal Propensity to Consume

Lifetime (present value) budget constraint:

$$\rho \cdot \underbrace{\sum_{t=1}^{T} c_t}_{\text{PV of cons.}} = T\bar{c} \cdot \rho = \underbrace{\sum_{t=1}^{T} (y_t - Tax_t)}_{\text{PV of income}} + a_1 \qquad (4)$$

Solve for consumption:

$\rho = 1$

$$\bar{c} = \frac{1}{T}\left[\sum_{t=1}^{T} (y_t - Tax_t) + a_1\right] \qquad (5)$$

MPC out of one year's income: $\partial\bar{c}/\partial y_t = 1/T$

- age $t = 20$; life-expectancy $T = 85 - 20$: MPC = $1/65$
- age $t = 50$; life-expectancy $T = 85 - 50$: MPC = $1/35$

Implications

$$\frac{dc_t}{dy_t}$$

The MPC out of **current** income should be **small** for most people.

- key, robust intuition ...

But **permanent** tax cuts are very different.

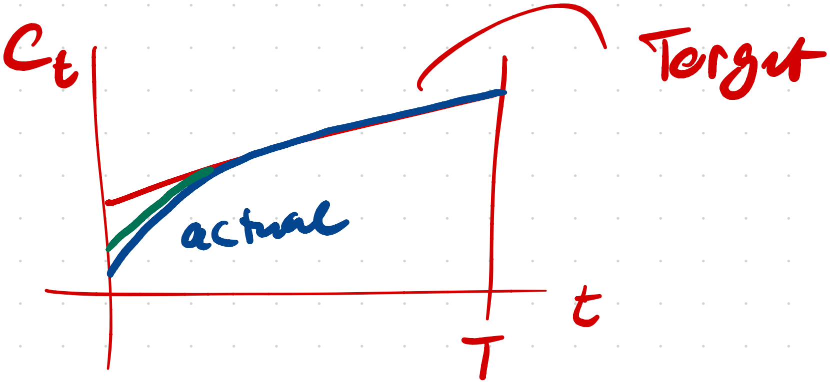
- MPC = ... 1

Expectations of future income matter a lot.

- we come back to that point later.

So one-time tax cuts are hopeless for stimulating the economy?

- who has a high MPC?


C_t
Target
actual
t
T

Implications

Tax cuts can be effective, but they need to target the right populations.

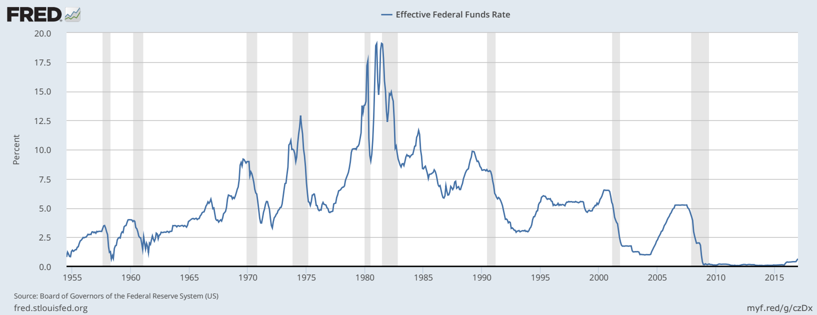
- tax cuts that benefit the rich are mostly saved
- tax cuts that benefit the poor are mostly consumed

Liquidity Traps

Liquidity Traps

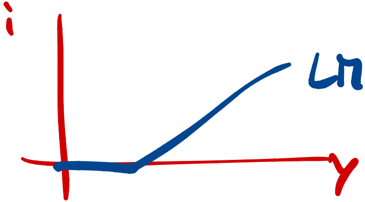
Real interest rates have been near zero for some time.

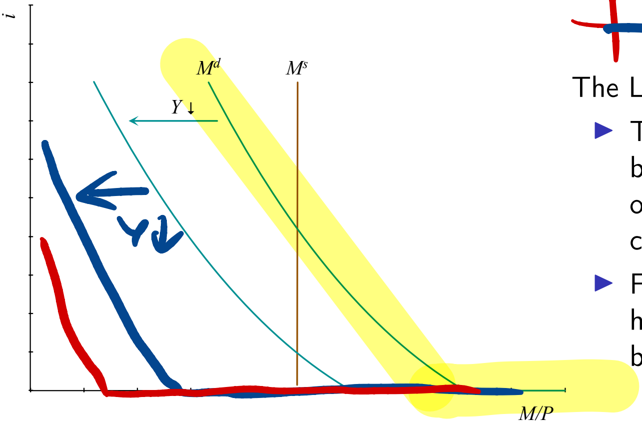
What does this imply for monetary policy?



Source: Fred

Liquidity Trap





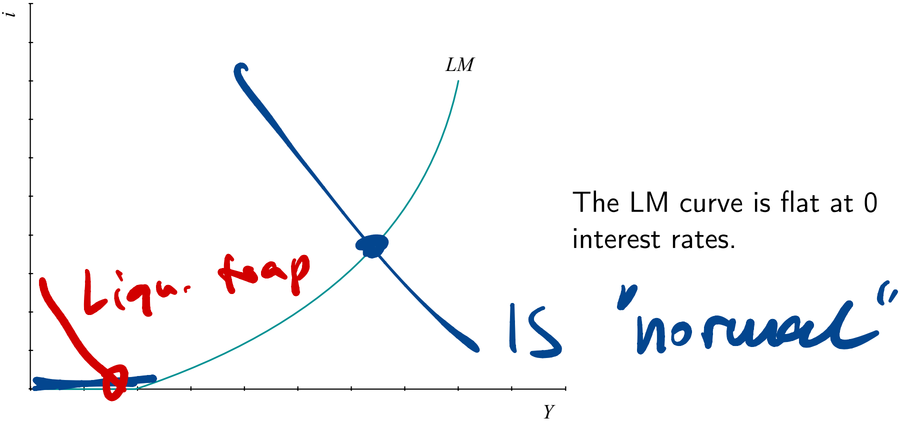
The LM curve turns flat

- The LM curve is derived by varying Y and tracing out $i, M/P$ points that clear the money market.
- For low Y the interest rate hits 0 and the LM curve becomes flat.

$i \downarrow$

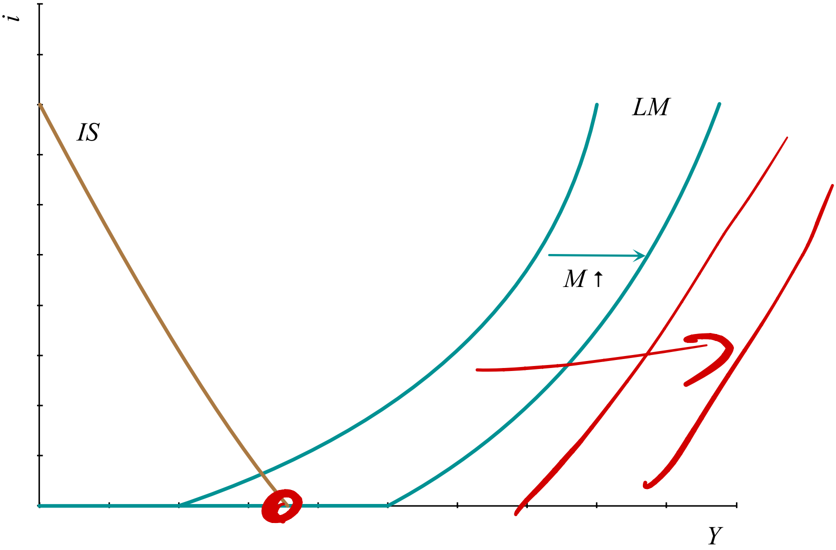
$\boxed{M \nrightarrow \text{bonds}}$

Liquidity Trap



The LM curve is flat at 0 interest rates.

Liquidity Trap: Monetary Policy

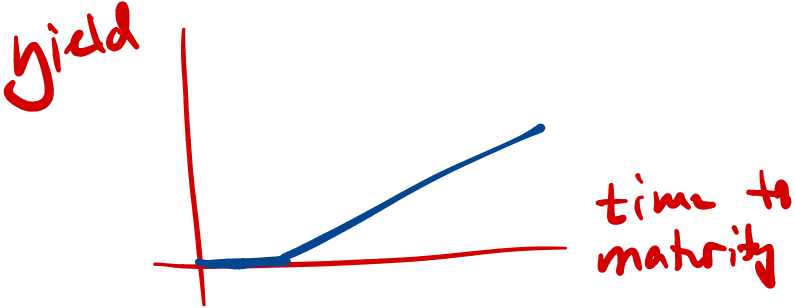


Monetary policy becomes ineffective

Policy options in a liquidity trap

If the interest rate is zero, what can the Fed do?

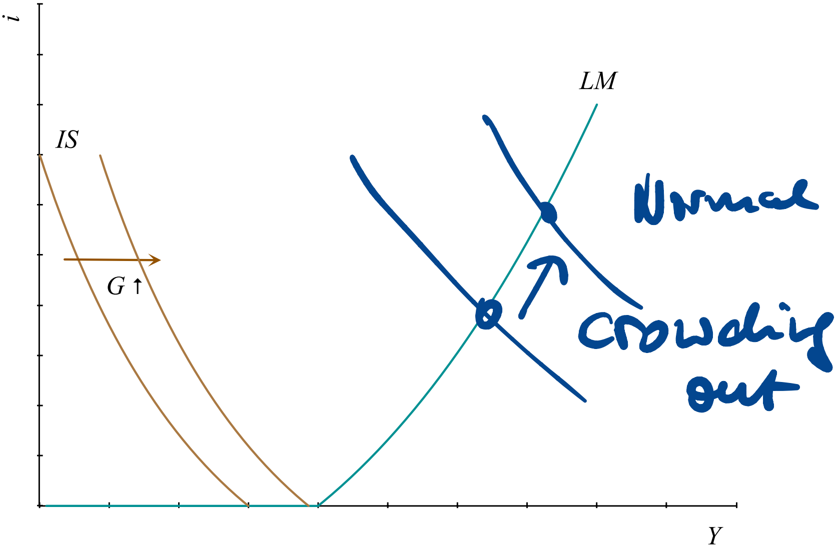
QE : buy "longer" bonds



$r = i - \pi^e$

Forward guidance

Liquidity Trap: Fiscal Policy



Fiscal policy becomes highly effective

The Role of Expectations

The Role of Expectations

Consumption and investment decisions are forward looking.

Future output increases today's spending.

Implications for policy:

1. Expectations become a policy tool.
2. Persistent policies are stronger than temporary ones.

Expectations: Monetary Policy

A monetary expansion now has 2 effects:

1. direct: $i \downarrow \Longrightarrow LM$ shifts right
2. indirect: expectations change

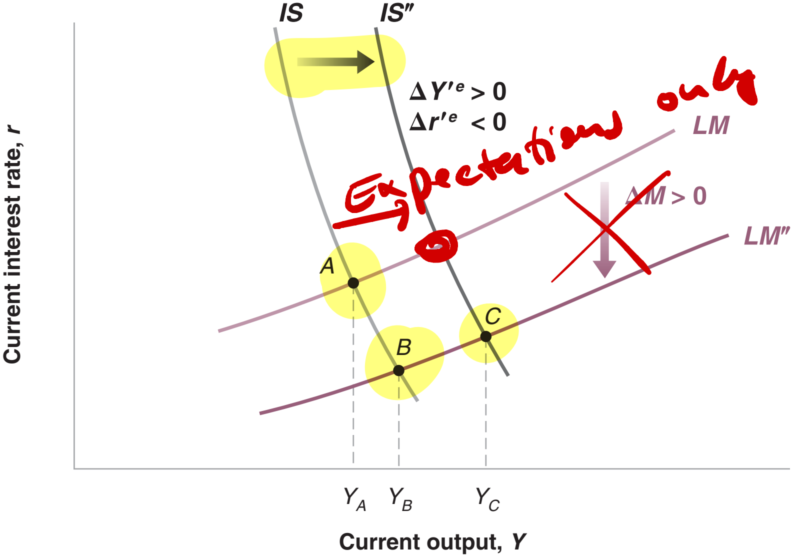
Transitory monetary expansion:

- no change in future Y', i' (primes denote future)
- small policy effect

Persistent monetary expansion:

- expect LM to stay shifted
- $Y' \uparrow$ and $i' \downarrow$
- IS shifts right as well

Expectations: Monetary Policy



Transitory $M\uparrow$: $A \rightarrow B$. Persistent $M\uparrow$: $A \rightarrow C$

Expectations: Monetary Policy

Key point

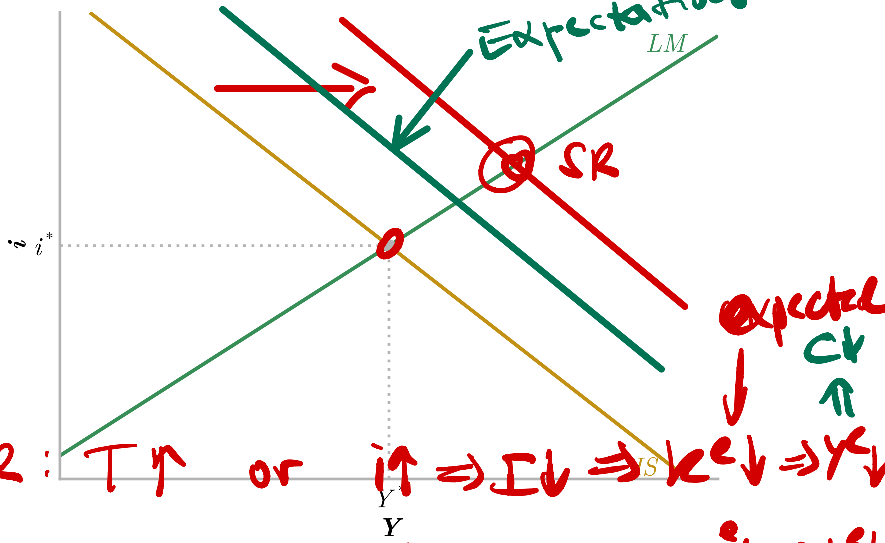
Monetary policy is more powerful, if it can change expectations.

Example

Quantitative Easing
The Fed buys large amounts of long-term bonds.
Signals that interest rates will remain low for a long time.

Expectations: Fiscal Policy

Can a cut in government spending stimulate aggregate demand?



LR: $T\uparrow$ or $i\uparrow \rightarrow I\downarrow \Rightarrow K^e\downarrow \Rightarrow Y^e\downarrow$

A Few Major Caveats

The IS-LM model makes the government look too powerful.

- By raising G it can achieve any level of Y.
- When is this a reasonable shortcut?

It looks like saving lowers output.

- What is missing?

Why Do We Still Have Recessions?

In the model, the government can stabilize output too easily.

Real world complications:

1. Big and variable lags until policies become effective
2. Lags in diagnosis and implementation of policies
3. Expansionary fiscal policies create debt
4. Expansionary monetary policies create inflation

An important point to remember

The IS-LM model makes strong assumptions: fixed prices, elastic supply, government can borrow without cost.
When applying the model, you need to consider how these assumptions modify the results.
(Or build a more comprehensive model)

Reading

Blanchard (2018), ch. 5 and 9.2; ch. 17 on expectations.

References I

Blanchard, O. (2018): *Macroeconomics*, Boston: Pearson, 8th ed.