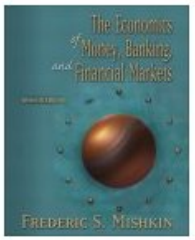
Money and Banking

ECON 354

Professor Yamin Ahmad

Lecture 9: The Building Blocks of Aggregate Demand

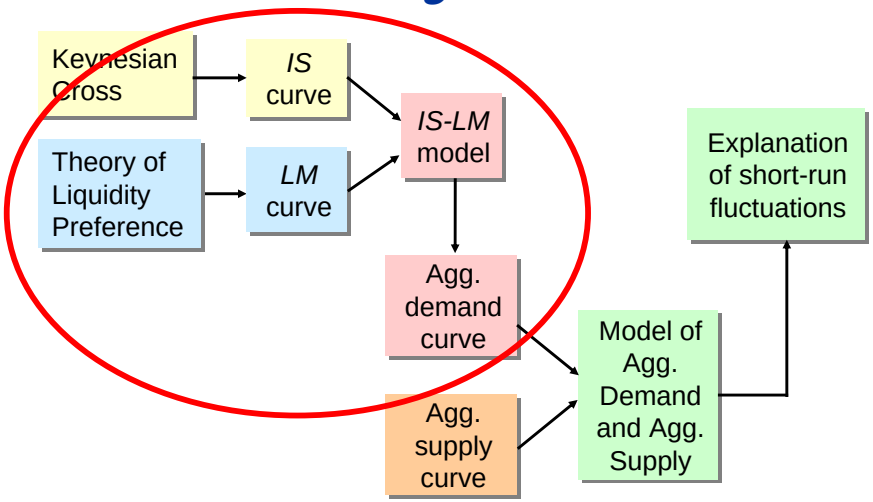
- Goods Market Equilibrium (IS Curve)
- Money Market Equilibrium (LM Curve)



Big Concepts in this lecture...

- the *IS* curve, and its relation to
  - the Keynesian cross
  - the loanable funds model
- the *LM* curve, and its relation to
  - the theory of liquidity preference
- how the *IS-LM* model determines income and the interest rate in the short run when ***P*** is fixed

The Big Picture



Context

- Second part of lecture 2 introduced the basic model of aggregate demand and aggregate supply.
- Long run
  - prices flexible
  - output determined by factors of production & technology
  - unemployment equals its natural rate
- Short run
  - prices fixed
  - output determined by aggregate demand
  - unemployment negatively related to output

The Keynesian Cross

- A (simpler) closed economy model in which income is determined by expenditure. *(due to J.M. Keynes)* – book does open economy version of model.
- Notation:
  - I = planned investment
  - $AE = C + I + G$ = planned expenditure
  - Y = real GDP = actual expenditure
- Difference between actual & planned expenditure = unplanned inventory investment

Elements of the Keynesian Cross

Consumption function: $C = C(Y - T)$

Govt policy variables: $G = \bar{G}, \quad T = \bar{T}$

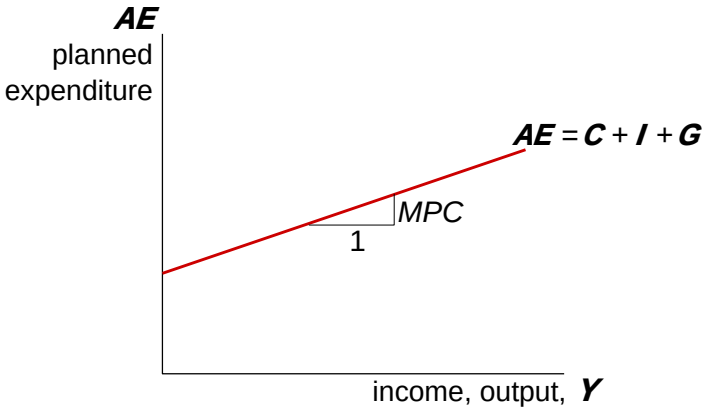
for now, planned Investment is exogenous: $I = \bar{I}$

planned expenditure: $AE = C\left(Y - \bar{T}\right) + \bar{I} + \bar{G}$

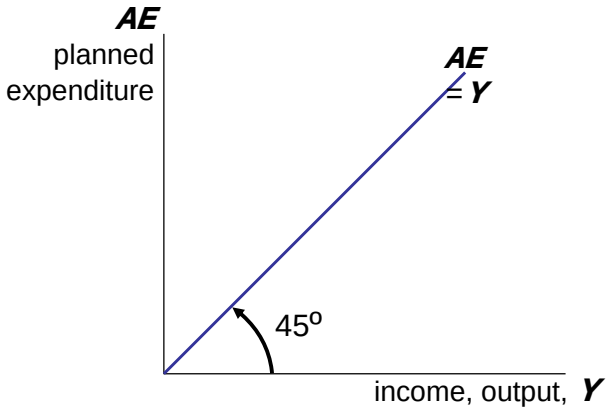
equilibrium condition: $Y = AE$

actual expenditure = planned expenditure

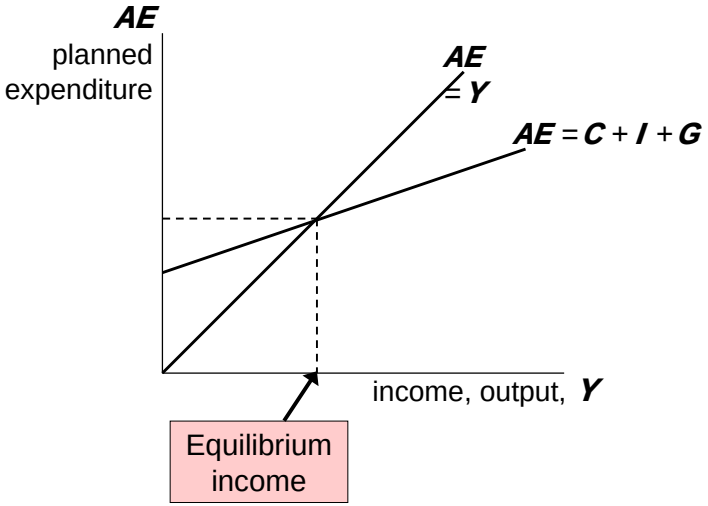
Graphing planned expenditure



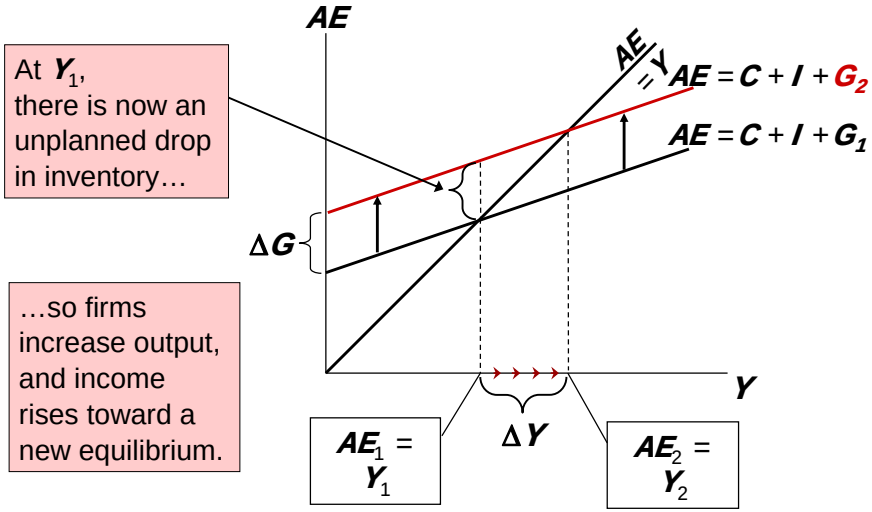
Graphing the equilibrium condition



The equilibrium value of income



An increase in government purchases



Solving for ΔY

$Y = C + I + G$ equilibrium condition

$\Delta Y = \Delta C + \Delta I + \Delta G$ in changes

$= \Delta C + \Delta G$ because I exogenous

$= \text{MPC} \times \Delta Y + \Delta G$ because $\Delta C = \text{MPC}\,\Delta Y$

Collect terms with ΔY on the left side of the equals sign:

$(1 - \text{MPC}) \times \Delta Y = \Delta G$

Solve for ΔY:

$$\Delta Y = \left(\frac{1}{1 - \text{MPC}} \right) \times \Delta G$$

The government purchases multiplier

Definition: the increase in income resulting from a \$1 increase in G.

In this model, the govt purchases multiplier equals

$$\frac{\Delta Y}{\Delta G} = \frac{1}{1 - \text{MPC}}$$

Example: If $MPC = 0.8$, then

$$\frac{\Delta Y}{\Delta G} = \frac{1}{1 - 0.8} = 5$$

An increase in G causes income to increase 5 times as much!

Why the multiplier is greater than 1

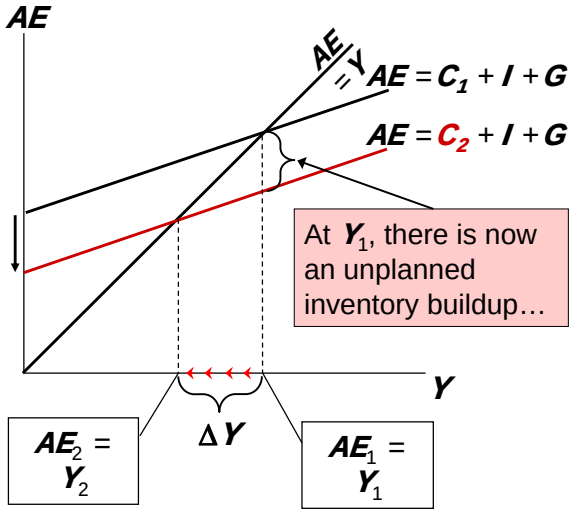
- Initially, the increase in ***G*** causes an equal increase in ***Y***: $\Delta Y = \Delta G$.
- But $\uparrow Y \Rightarrow \uparrow C$
  $\Rightarrow$ further $\uparrow Y$
  $\Rightarrow$ further $\uparrow C$
  $\Rightarrow$ further $\uparrow Y$
- So the final impact on income is much bigger than the initial ΔG.

An increase in taxes

Initially, the tax increase reduces consumption, and therefore ***E***:

$\Delta C = -\text{MPC}\,\Delta T$

…so firms reduce output, and income falls toward a new equilibrium



At Y_1, there is now an unplanned inventory buildup…

Solving for ΔY

$\Delta Y = \Delta C + \Delta I + \Delta G$ eq'm condition in changes

$= \Delta C$ ***I*** and ***G*** exogenous

$= \text{MPC} \times (\Delta Y - \Delta T)$

Solving for ΔY: $(1 - \text{MPC}) \times \Delta Y = -\text{MPC} \times \Delta T$

Final result:

$$\Delta Y = \left(\frac{-\text{MPC}}{1 - \text{MPC}} \right) \times \Delta T$$

The tax multiplier

Def: the change in income resulting from a \$1 increase in ***T*** :

$$\frac{\Delta Y}{\Delta T} = \frac{-\text{MPC}}{1 - \text{MPC}}$$

If *MPC* = 0.8, then the tax multiplier equals

$$\frac{\Delta Y}{\Delta T} = \frac{-0.8}{1 - 0.8} = \frac{-0.8}{0.2} = -4$$

The tax multiplier

…is *negative:*
A tax increase reduces ***C***, which reduces income.

…is *greater than one* (*in absolute value*):
A change in taxes has a multiplier effect on income.

…is *smaller than the govt spending multiplier:*
Consumers save the fraction (1 – *MPC*) of a tax cut, so the initial boost in spending from a tax cut is smaller than from an equal increase in ***G***.

Walkthrough Example I:

Economic Scenario:

In the Keynesian Cross, assume that the consumption function is given by:

$$C = 475 + 0.75(Y-T)$$

Planned Investment, I = 150, G = 250, T = 100.

a. Graph planned expenditure as a function of income
b. What is the equilibrium level of income
c. If government purchases increase by 125, what is the new equilibrium income?
d. What level of government purchases is needed to achieve an income of 2600?

A Balanced Budget Approach

Problem:

- Suppose that we face our canonical problem where
  - C=475 + 0.75(Y-T), T = 100
  - I = 150, G = 250
- Suppose that the government wishes to increase its spending by 100, but uses a balanced budget approach, thereby raising taxes by the same amount to finance its expenditures.
- Question: Is there any impact on GDP? Does it change? If so, by how much?

Balanced Budget Change in G

Solution:

Suppose Δ G = Δ T=100. In equilibrium, $\boldsymbol{Y = AE}$

$$Y = \frac{c_0 + I + G - c_1 T}{1 - c_1}$$

Hence

$$\Delta Y = \frac{\Delta G - c_1 \Delta T}{1 - c_1} = \frac{\Delta G - c_1 \Delta G}{1 - c_1} = \Delta G = 100$$

i.e. $\frac{\Delta Y}{\Delta G} = 1$ so our **balanced budget multiplier** = 1

Why?

$$\Delta Y = \Delta G + c_1 \Delta G + c_1^2 \Delta G + c_1^3 \Delta G + c_1^4 \Delta G + \ldots$$
$$- c_1 \Delta T - c_1^2 \Delta T + c_1^3 \Delta T + c_1^4 \Delta T + \ldots = \Delta G$$

The *IS* curve

Def: a graph of all combinations of r and Y that result in goods market equilibrium

i.e. actual expenditure (output)
= planned expenditure

The equation for the *IS* curve is:

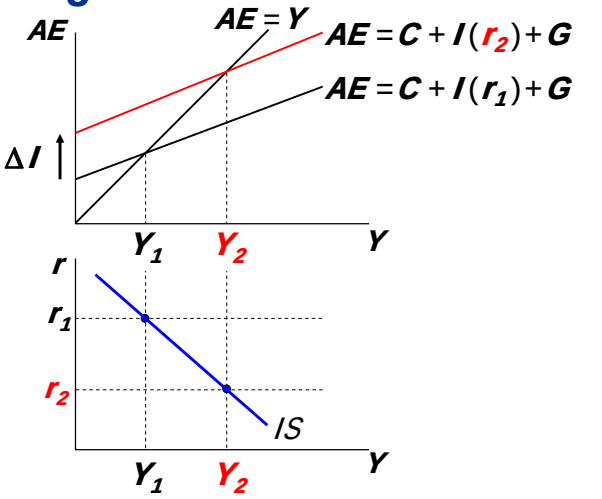
$$Y = C(Y - \overline{T}) + I(r) + \overline{G}$$

Deriving the *IS* curve

$\downarrow r \Rightarrow \uparrow I$

$\Rightarrow \uparrow AE$

$\Rightarrow \uparrow Y$



Why the *IS* curve is negatively sloped

- A fall in the interest rate motivates firms to increase investment spending, which drives up total planned spending (***AE***).
- To restore equilibrium in the goods market, output (*a.k.a.* actual expenditure, ***Y***) must increase.

Market For Loanable Funds – Closed Economy

Define $S_p \equiv Y-T-C(Y-T)$ and $S_g \equiv T-G$
(+)

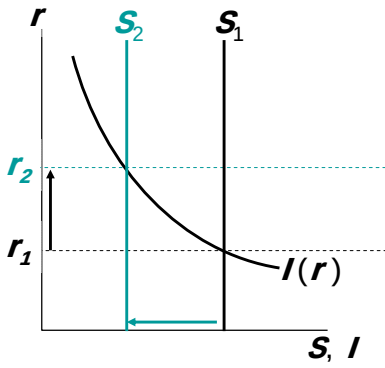
$\Rightarrow S \equiv S_p + S_g = Y - C(Y-T) - G = S(Y; G, T)$
(+) (-) (+)

Capital Markets Equilibrium: S(Y;G,T) = I(r)
(Loanable Funds) (-)

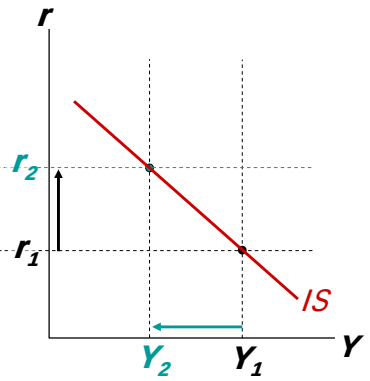
Or Equivalently: $Y = Y^d \equiv C(Y-T) + I(r) + G$

The *IS* curve and the loanable funds model

(a) The L.F. model



(b) The *IS* curve



Algebra Of The IS Curve

Suppose $C = c_0 + c_1(Y-T)$ and $I = I_0 - br$

(Note: Blanchard also considers the effect of sales on Investment by incorporating Y, i.e. $I=b_0+b_1Y-b_2r$)

Then $Y = C + I + G$

$= c_0 + I_0 + G + c_1(Y-T) - br$

If we collect like terms:

$$Y = \frac{c_0 + I_0 + G - c_1 T}{1 - c_1} - \frac{b}{1 - c_1} r$$

Slope of the IS curve

$$Y = \frac{c_0 + I_0 + G - c_1 T}{1 - c_1} - \frac{b}{1 - c_1} r$$

Hold everything except Y and r fixed:

$$\Delta Y = \frac{-b}{1 - c_1} \Delta r \quad \Rightarrow \quad \frac{\Delta r}{\Delta Y} = \frac{c_1 - 1}{b} < 0$$

Thus IS is relatively flat if either:

(i) b is very large; or

(ii) (ii) c close to unity.

Walkthrough Example II:

Economic Scenario: Consider the following IS-LM model:

Goods Market: C = 200+0.5(Y-T); I = 200 – 1000r; G = 250; T = 200

Question:

- Derive the IS relation (i.e. an equation with Y on one side and everything else on the other)

Solution

Fiscal Policy and the *IS* curve

- We can use the *IS-LM* model to see how fiscal policy (***G*** and ***T***) affects aggregate demand and output.
- Let's start by using the Keynesian cross to see how fiscal policy shifts the *IS* curve…

Shifting the *IS* curve: ΔG

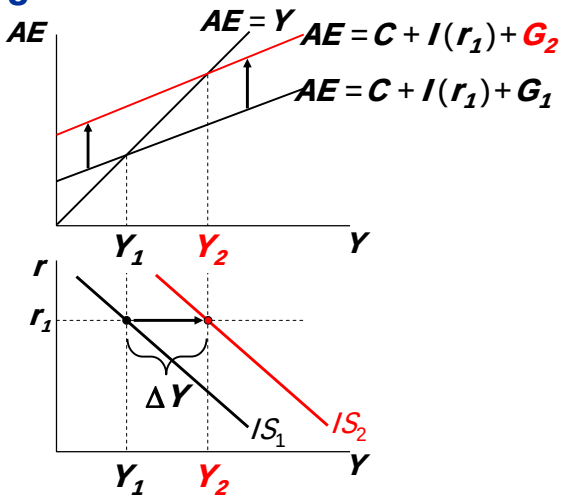
At any value of ***r***,

$\uparrow G \Rightarrow \uparrow AE \Rightarrow \uparrow Y$

…so the *IS* curve shifts to the right.

The horizontal distance of the *IS* shift equals

$$\Delta Y = \frac{1}{1-\text{MPC}} \Delta G$$



Recall: The Theory of Liquidity Preference

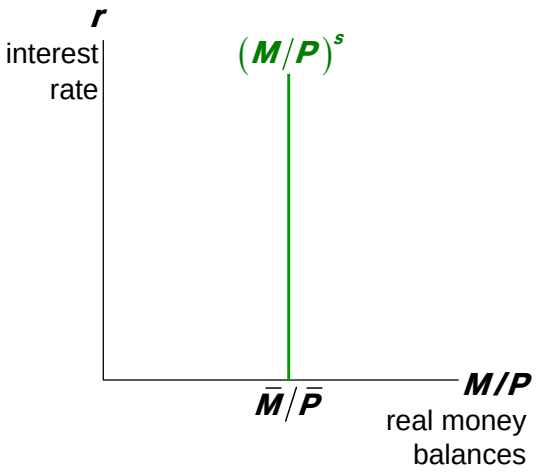
- Due to John Maynard Keynes.
- A simple theory in which the interest rate is determined by money supply and money demand.
- Money supply is exogenous – determined by Fed!
- People hold wealth in the form of either:
  - Money
  - Bonds

  } Demand for money and demand for bonds!

Money supply

The supply of real money balances is fixed:

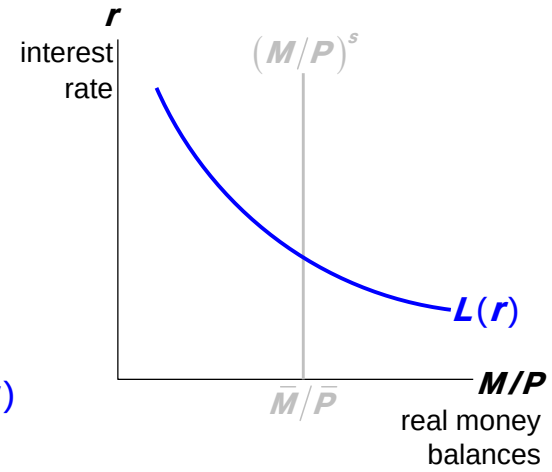
$$\left(M/P\right)^s = \bar{M}/\bar{P}$$



Money demand

- People either hold:
  - Money
  - Bonds
- Demand for real money balances:

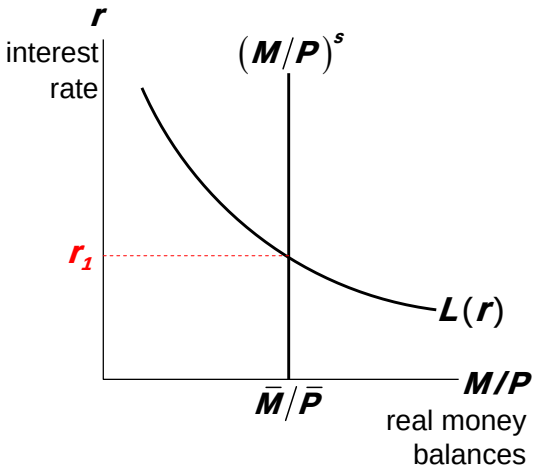
$$(M/P)^d = L(r)$$



Equilibrium

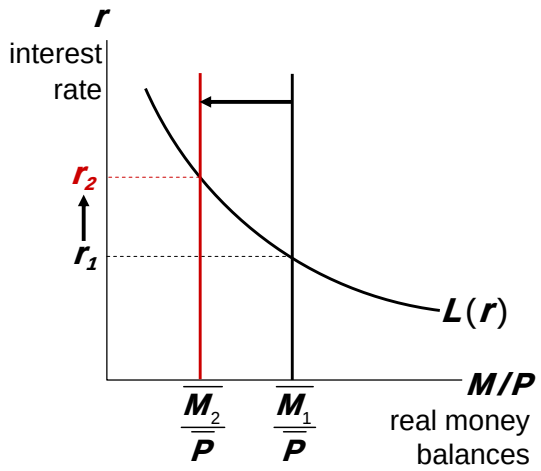
The interest rate adjusts to equate the supply and demand for money:

$$\bar{M}/\bar{P} = L(r)$$



How the Fed raises the interest rate

To increase *r*, Fed reduces *M*



CASE STUDY:

Monetary Tightening & Interest Rates

- Late 1970s: π > 10%
- Oct 1979: Fed Chairman Paul Volcker announces that monetary policy would aim to reduce inflation
- Aug 1979-April 1980: Fed reduces *M/P* 8.0%
- Jan 1983: π = 3.7%

How do you think this policy change would affect nominal interest rates?

Monetary Tightening & Rates, *cont.*

The effects of a monetary tightening on nominal interest rates		
	short run	long run
model	Liquidity preference *(Keynesian)*	Quantity theory, Fisher effect *(Classical)*
prices	sticky	flexible
prediction	$\Delta i > 0$	$\Delta i < 0$
actual outcome	8/1979: i = 10.4% 4/1980: i = 15.8%	8/1979: i = 10.4% 1/1983: i = 8.2%

The *LM* curve

Now let's put Y back into the money demand function:

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

Note: In Blanchard: $\left(\frac{M}{P}\right)^d = YL(i) = d_1 Y - d_2 i$

The ***LM* curve** is a graph of all combinations of r and Y that equate the supply and demand for real money balances.

The equation for the *LM* curve is: $\bar{M}/\bar{P} = L(r,Y)$

Nominal or Real Rates in Money Demand?

Money Market Equilibrium: $\frac{\overline{M}}{P} = \left(\frac{M}{P}\right)^d = \underset{(-)(+)}{L(i,Y)}$

What is real return to saving \$1?

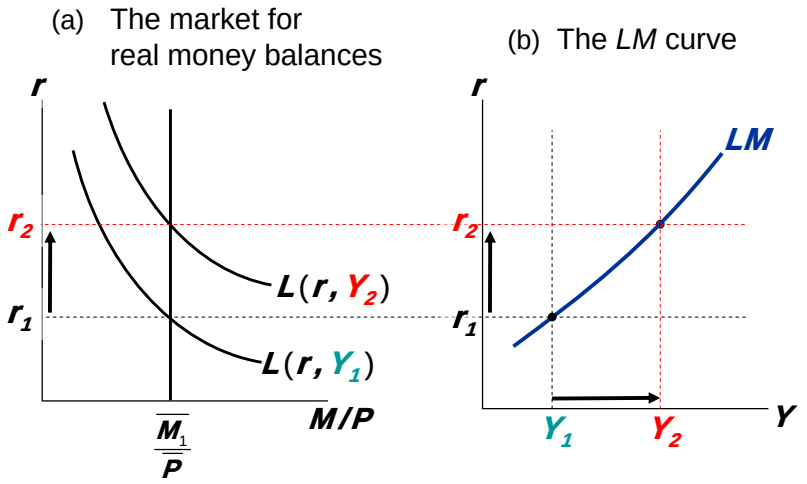
$$1 + r = \frac{1+i}{1+\pi} \quad \Rightarrow \quad r + \pi \approx i$$

This is known as the Fisher Equation.

So: $\frac{\overline{M}}{P} = L(r+\pi, Y)$

Treat M^s as exogenous; for present set $\pi = 0$.

Deriving the *LM* curve



Why the *LM* curve is upward sloping

- An increase in income raises money demand.
- Since the supply of real balances is fixed, there is now excess demand in the money market at the initial interest rate.
- The interest rate must rise to restore equilibrium in the money market.

Equilibrium in the Bond Market?

There are two assets (money and bonds), but only one equilibrium condition. Do we need to worry about bond market equilibrium as well? Answer: No!

$$\frac{M^S}{P} + B^S = A = \left(\frac{M}{P}\right)^d + B^d$$

with A = real wealth.

So: $\frac{M^S}{P} = \left(\frac{M}{P}\right)^d \Leftrightarrow B^S = B^d$

This is an example of Walras Law.

Algebra of the LM Curve

Write: $\left(\frac{M}{P}\right)^d = m_0 + kY - hr$

With M and P fixed: $0 = k\Delta Y - h\,\Delta r$

Slope of LM Curve : $\frac{\Delta r}{\Delta Y} = \frac{k}{h} > 0$

LM curve relatively flat if either:

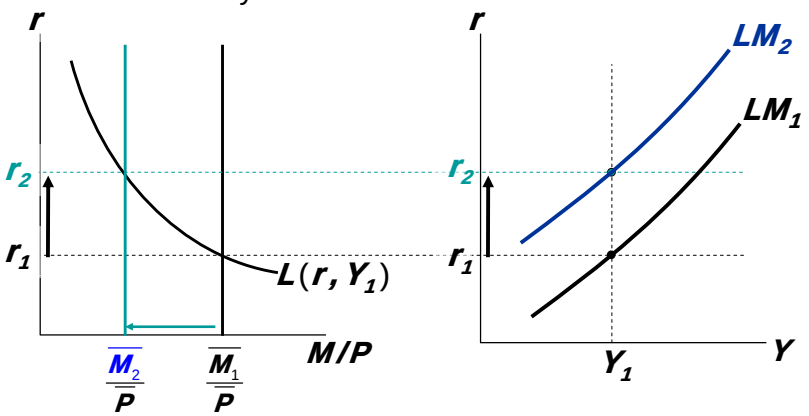
(i) k small; or

(ii) (ii) h large (" Liquidity Trap")

How ΔM shifts the *LM* curve

(a) The market for real money balances

(b) The *LM* curve



Shifts in LM curve (r fixed)

$$\frac{\Delta M}{P} = k\Delta Y \Rightarrow \frac{\Delta Y}{\Delta M} = \frac{1}{Pk}$$

What happens if $k = 0$?

Hold Y fixed:

$$\frac{\Delta M}{P} = -h\Delta r \Rightarrow \frac{\Delta r}{\Delta M} = -\frac{1}{Ph}$$

- So vertical shift is independent of k

Walkthrough Example III:

Economic Scenario:

Suppose that the money demand function is:

$(M/P)^d = 1000 - 100r$

where r is the interest rate (in percent). The money supply M is 1000, and the price level is 2.

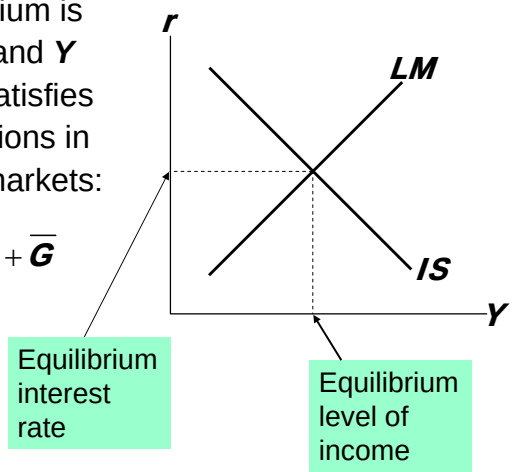
a. Graph the supply and demand for real money balances.
b. What is the equilibrium interest rate?
c. Assume that the price level is fixed. What happens to the equilibrium interest rate if the supply of money is raised from 1000 to 1200?
d. If the Fed wishes to raise the interest rate to 7 percent, what money supply should it set?

The short-run equilibrium

The short-run equilibrium is the combination of ***r*** and ***Y*** that simultaneously satisfies the equilibrium conditions in the goods & money markets:

$$Y = C(Y - \bar{T}) + I(r) + \bar{G}$$

$$\bar{M}/\bar{P} = L(r, Y)$$



Equilibrium With Fixed Prices

IS Curve

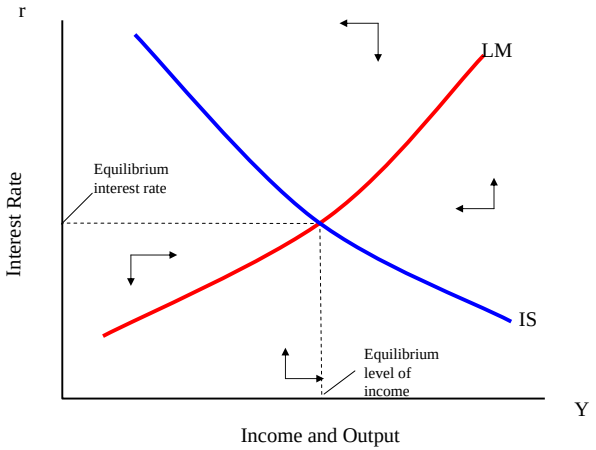
$$\underset{(+)(-)(+)}{S(Y;G,T) = I(r)} \quad \left(\text{or } Y = \frac{c_0 + I_0 + G - c_1 T}{1 - c_1} - \frac{br}{1 - c_1} \right)$$

LM Curve

$$\frac{M}{P} = \underset{(-)(+)}{L(r,Y)} \qquad (\text{or } \frac{M}{P} = m_0 + kY - hr)$$

Solve for Y and r in terms of G,T, M and P.

Equilibrium in the IS-LM Model



- Is there any reason to expect it to converge to this equilibrium from arbitrary r and Y?
- If there is an excess demand for money (excess supply of bonds) this should drive the return on bonds up, and vice versa.
- If savings exceeds planned investment, then consumers must be spending less and producers will be accumulating unwanted inventories. So they will cut back production, and vice versa.
- Hence the system should converge.

$$Y = \frac{c_0 + I_0 + G - c_1 T}{1 - c_1} - \frac{b}{1 - c_1}\left(\frac{m_0 + kY - M/P}{h}\right)$$

$$= \frac{c_0 + I_0 + G - c_1 T - bm_0/h + bM/hP}{1 - c_1 + bk/h}$$

What is this???

Hence:

$$\frac{\Delta Y}{\Delta G} = \frac{1}{1 - c_1 + bk/h} > 0 \text{ and } \to 0 \text{ as } h \to 0$$

$$\frac{\Delta Y}{\Delta M} = \frac{b}{hP(1 - c_1 + bk/h)} > 0 \text{ and } \to 0 \text{ as } b \to 0 \text{ or } h \to \infty$$

Walkthrough Example IV:

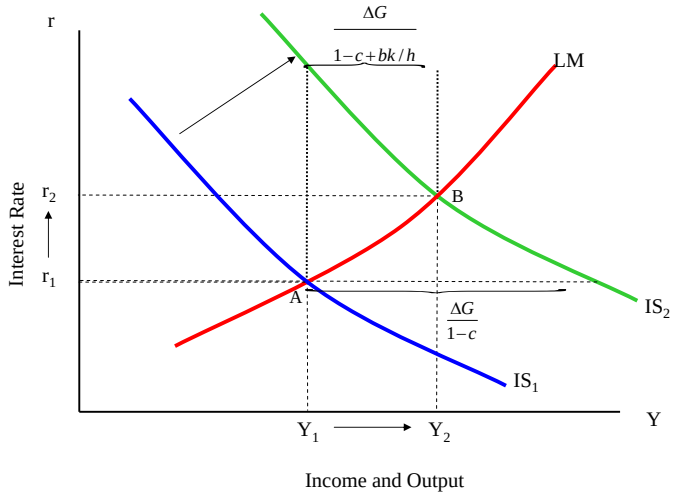
Economic Scenario: Consider the following IS-LM model:

Goods Market: C = 200+0.5(Y-T); I = 200 – 1000r; G = 250; T=200

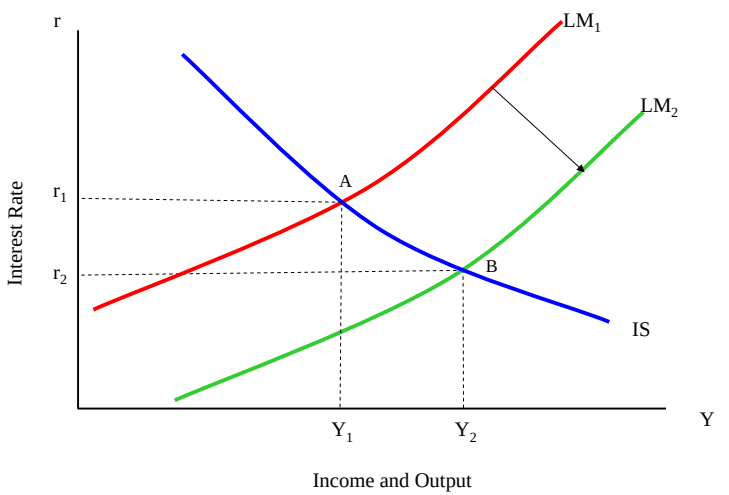
Money Market: M = 3000; P = 2; L(r,Y)= 2Y – 10000r

a. Derive the IS relation (i.e. an equation with Y on one side and everything else on the other)
b. Derive the LM relation
c. Solve for equilibrium real GDP (Y*) and interest rate (r*)
d. Solve for the equilibrium values of C, I and G (- verify you get Y by adding up C+I+G)
e. Suppose that the Fed increases money supply by 280, i.e. ΔM=280. Solve for Y*, r*, C and I. Describe what happens
f. Set M back to its initial value. Now suppose the government increases spending by 70, i.e. ΔG = 70. Solve for Y*, r*, C and I. Describe what happens.

Fiscal Expansion



Monetary Expansion



Summary

1. Keynesian cross
   - basic model of income determination
   - takes fiscal policy & investment as exogenous
   - fiscal policy has a multiplier effect on income.
2. *IS* curve
   - comes from Keynesian cross when planned investment depends negatively on interest rate
   - shows all combinations of ***r*** and ***Y*** that equate planned expenditure with actual expenditure on goods & services

Summary

3. Theory of Liquidity Preference
   - basic model of interest rate determination
   - takes money supply & price level as exogenous
   - an increase in the money supply lowers the interest rate
4. *LM* curve
   - comes from liquidity preference theory when money demand depends positively on income
   - shows all combinations of ***r*** and ***Y*** that equate demand for real money balances with supply

Summary

5. *IS-LM* model
   - Intersection of *IS* and *LM* curves shows the unique point (***Y***, ***r***) that satisfies equilibrium in both the goods and money markets.