IS-LM Model

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Reading

- Mankiw and Taylor (2008), Macroeconomics: Chapter 10.1 and .2 and 11.1

Plan for Next Three Lectures

- IS curve
- LM curve
- ISLM equilibrium
- Fiscal/monetary policy in ISLM model
- Policy applications

Basic Assumptions

- Closed economy.
- Exogenously fixed nominal price level, P.
- Inflation expectations are exogenous.
- $r = i$.
- There is one basket of goods.

Keynesian Cross and Investment Demand

- Keynesian Cross shows planned expenditure (E^p):

$$E^p \equiv C + I + G$$

or,

$$E^p \equiv \overbrace{C(\underbrace{Y - T}_{\text{disp. incm}})}^{\text{hhlds}} + \overbrace{I^p(r)}^{\text{firms}} + \overbrace{G}^{\text{govt.}}$$

- Consumption rises with income: $\Delta C / \Delta Y > 0$.
- National saving, S, is composed of private saving $(Y - T - C)$ plus government saving $(T - G)$. Saving equals investment:

$$S = I$$

Keynesian Cross and Investment Demand

- Keynesian Cross:

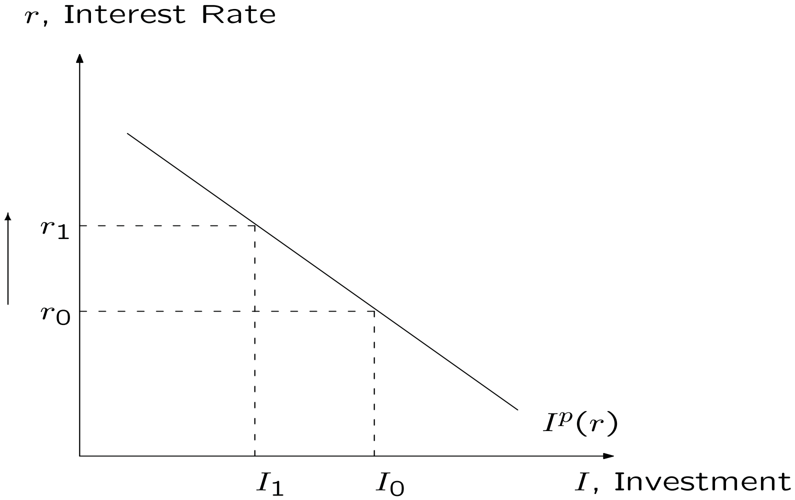
1. Equilibrium: planned expenditure=spending (income): $E^p = Y$.
2. Higher r, lowers I, which lowers E^p s.t. $E_1^P < Y_0$. Y decreases from Y_0 to Y_1 to reach equilibrium - ΔI 'faster' than ΔY.[1]

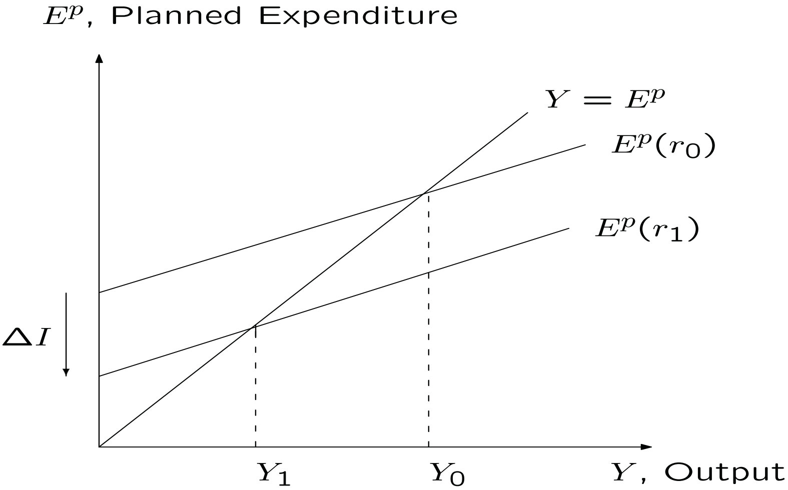
- Investment Demand:

1. Investment falls with the real interest rate (I^p is planned investment): $\Delta I^p / \Delta r < 0$.
2. We typically assume there is a linear relationship.

[1] We also see that investment is more variable than output in the data.

Investment Demand Schedule




E^p, Planned Expenditure
$Y = E^p$
$E^p(r_0)$
$E^p(r_1)$
$\triangle I$
Y_1
Y_0
Y, Output

From the Keynesian cross to IS Curve

- **IS Curve:** combinations of real output (GDP) and (real) interest rate such that **planned** and **actual expenditures are equal**.

$$E^p = E(Y, r, G, T) \equiv C(Y - T) + I^p(r) + G$$

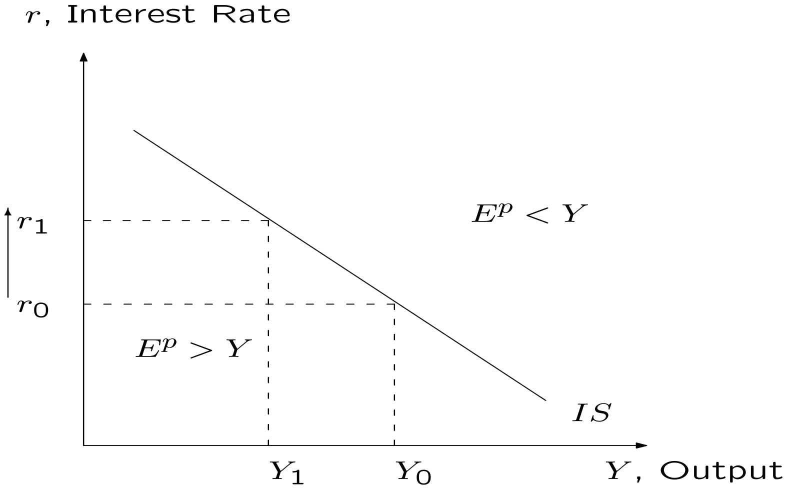
Totally differentiating $C(Y - T) + I^p(r) + G$ w.r.t. Y and r (assuming fiscal policy (G and T) is fixed) yields:

$$\Delta Y = \Delta E^p = C_Y \Delta Y + I_r \Delta r$$

where $0 < C_Y < 1$ is the MPC (and slope of the planned exp. line in the Keynesian cross diagram) and $I_r < 0$. So,

$$(\Delta Y) / (\Delta r)|_{IS} = I_r / (1 - C_Y) < 0$$

The IS Curve



Slope of the IS Curve

- A given **change in the interest rate** will have a bigger impact on output the flatter the *IS* curve. That is, if either:

1. The interest sensitivity of planned expenditure (via investment I_r) is high $\Rightarrow$ **planned expenditure line shifts further**, so output falls further.
2. The marginal propensity to consume out of disposable income (C_Y) is large $\Rightarrow$ higher *MPC* implies **steeper planned expenditure line**, so output must fall further in response to a given downward shift of the planned expenditure line to return to planned $=$ actual expenditure.

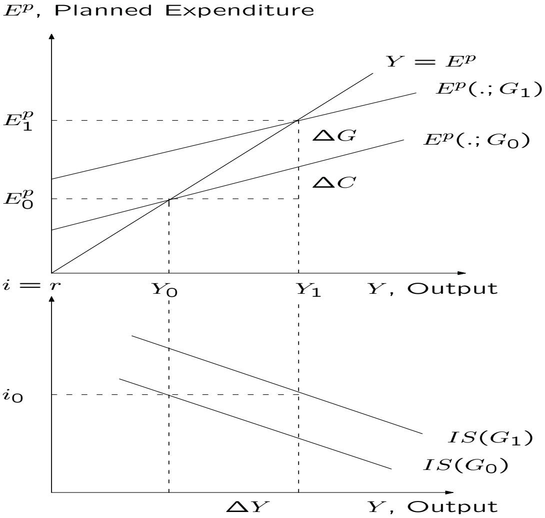
Shifting the IS Curve

- Assume $r = i$ is fixed. Increase in government purchases G (in general, change autonomous spending).
- Recall, $Y = C(Y - T) + I^p(r) + G$, then differentiate w.r.t. Y and G, with T, $I^p(r)$ fixed $\Rightarrow$ $\Delta Y = C_Y \Delta Y + \Delta G$, and rearrange $\Rightarrow$ the government purchases multiplier is:

$$(\Delta Y) / (\Delta G)|_r = 1/(1 - C_Y) > 1$$

- Magnitude of govt purchases multiplier: $0 < (C_Y = MPC) < 1$ so $1/(1 - C_Y) > 1$.
- **Intuition:** An increase in G raises private income. This raises consumption, which itself raises private income. Thus there is a multiplied effect of government spending.

Government Spending



Comments

- The Keynesian cross and IS curve actually show the same thing. The difference is that we represent them in different spaces.
- The Keynesian cross in (E^p, Y) space and the IS in (r, Y) space.
- In (r, Y) space, we have to hold the interest rate fixed when we look at the effects of government spending.
- To complete the analysis we also need to include the money and bonds markets alongside the goods market.
- In this case, we can see what impact changes in fiscal policy have on things such as the interest rate.

Money and Bonds Portfolio

- Agents have access to two assets

1. they hold **money** (M) to **spend** on goods.
2. they hold **bonds** (B, e.g. consols: pay fixed yearly amount (\$1) forever, starting next year) to **save**, i.e. spend in the future

- Real financial wealth, A, is given by:

$$A = M^s/P + (P_B/P)B^s$$

where, s denotes stock.

- A is basically a reflection of the portfolio of an individual.

The Bond Market

- B^s is the total number of bonds issued ($=$ volume of bonds) and the price of bonds is P_B (so $P_B B^s$ is nominal value of bonds)
- Assume the demand for bonds is given by:

$$B^d(\underset{+}{i}, \underset{+}{Y})$$

- If income rises so does the demand to hold bonds - some income is held in cash to buy goods now, some in bonds, to buy goods later.
- If the interest rate rises ('payoff' from holding the bond) the price of bonds falls and bond demand increases.

The Money Market

- Money stock equals currency and liquid bonds (regular bonds are illiquid within period).
- Treat supply of nominal money balances M^s as exogenous. Recall that the price level, P, is exogenous (and assumed fixed).
- The demand for money is given by:

$$(M/P)^d = L(\underset{-}{i}, \underset{+}{Y})$$

- $\Delta L/\Delta i \equiv L_i < 0 \Rightarrow$ if the interest rate goes up you put more into bonds (money bears no interest).
- $\Delta L/\Delta Y \equiv L_Y > 0 \Rightarrow$ if your income goes up, you consume more now. To do this you need more money.

More on Money Demand

- Revision comments:
  - $i =$ opportunity cost of holding money (i.e. you could put you money into bonds and get interest back).
  - $L(\cdot)$ stands for **Liquidity Preference**.
- The role of money more generally is as a ...
  - **medium of exchange:** intermediary used in trade to avoid a pure barter system.
  - **store of value:** measurement of the market value of goods.
  - **unit of account:** able to be reliably saved, stored, and retrieved
- M^s, i.e. valueless money, is called Fiat money.[2]

[2] Think: not gold coins.

Equilibrium

- If the money market is in equilibrium so is the bond market. That is:

$$M^s/P - L(i,Y) = (P_B/P)\left[B^d(i,Y) - B^s\right]$$

- If $M^s/P > M^d/P \equiv L(i,Y) \Rightarrow B^d(i,Y) > B^s$ etc. Given Y and P, i falls to clear the market.
- We also need to impose that money demand equal money supply:

$$M^s/P = (M/P)^d$$

- Now we have an LM curve:

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

where M^s is exogenous.[3]

[3] We usually think of M^s as $M0$ (notes and coins). Other types include $M2$, $M4$, which are broader definitions.

LM Curve

- LM curve shows combinations of real output and interest rate such that the money market is in equilibrium, for a given price level.

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

- Again: $\Delta L/\Delta i \equiv L_i < 0$ and $\Delta L/\Delta Y \equiv L_Y > 0$.
- **Note:** we use the nominal interest rate for the LM and the real interest rate for the IS.

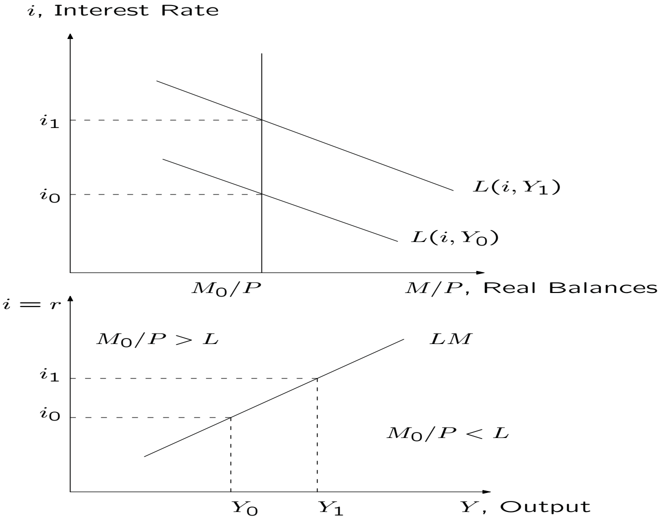
1. the nominal interest rate affects individuals portfolio decision b/w money and bonds.
2. the real interest rate affects firms investment decisions.

..... however, we have assumed $i = r$.

Changes in Output

- Although output is endogenous, we can ask what happens if it changes.
- Suppose $Y_1 > Y_0$. This raises money demand, $L(i, Y)$.
- As M^s/P is fixed $M^s < M^d$ and L needs to fall.
- However, $M^s < M^d$ is consistent with $B^d(i, Y) < B^s$.
- As B^s is fixed, the price of bonds falls, which is equivalent to a higher interest rate (that is, a higher payoff to holding a bond).

Money Market and LM Curve



Slope of the LM Curve

- LM curve slopes upwards in (i, Y) space. This can be seen by totally differentiating $M^s/P = L(i, Y)$ w.r.t. i, Y:

$$0 = L_i \Delta i + L_Y \Delta Y$$

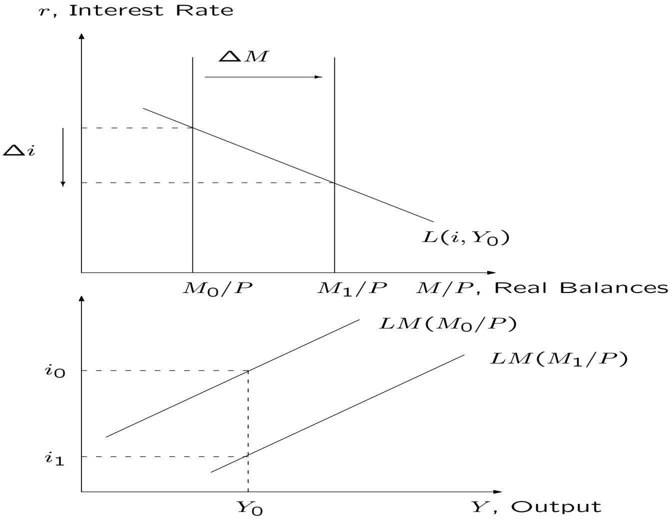
- So, $(\Delta i)/(\Delta Y)|_{LM} = -L_Y/L_i > 0$ as $L_Y > 0$ and $L_i < 0$.
- **A given change in income** will have a smaller impact on the interest rate along the LM curve, i.e. the LM curve is relatively flat, either

1. the lower the income sensitivity of money demand, L_Y (i.e., the increase in money demand is less when output rises).
2. the higher the interest sensitivity of money demand, L_i.

Shifting the LM Curve

- So far, M^s has been fixed. However, it can also be a policy variable.
- Suppose there is an increase in M^s.
- This implies $M^s > M^d$ at the current interest rate and so individuals prefer to buy bonds rather than hold this extra cash.
- This raises the price of bonds and i falls to clear the market.
- People are now happy to hold the additional money balances and the money market returns to equilibrium at a lower interest rate.

Shifting the LM Curve



The Short-Run ISLM Equilibrium

- Recap

1. IS Curve gives combinations of real output (GDP) and **real interest rate** such that planned and actual expenditures on real output are equal.
2. LM Curve gives combinations of real output and **nominal interest rate** such that the money market is in equilibrium, for a given price level.

- As $r = i$ we can plot the IS and LM conditions in $(i = r, Y)$ space as we have two conditions in two unknowns.

Stability of the ISLM Equilibrium

Goods Market:

$$Y = E^p = C(Y - T) + I^p(r) + G$$

If $Y > E^p$ goods demand is too low, firms accumulate unwanted inventories $(I_0 > 0)$, so they cut back on production. And $Y < E^p \Rightarrow I_0 < 0$.

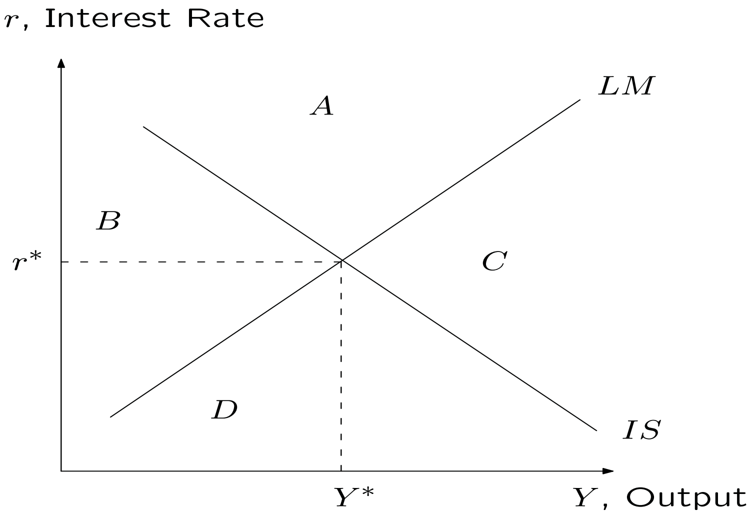
Money Market:

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

If $M^s > M^d$, then bond supply is less than bond demand and the interest rate falls to clear the market. With $M^d > M^s$, it is the opposite.

Equilibrium:
$M^s = M^d$ and $Y = E^p$.

IS-LM Equilibrium



Round-up of ISLM so far ...

- ISLM captures the **demand side** and is **short-run** focused.
- **Firms** invest and **households** consume, hold money and save (buy bonds to consume later).
- ISLM is not really concerned with production - i.e. where the goods come from. That is the supply side.
- Next we want to consider policy options.

Functional Forms

- In macro we often adopt specific functional forms:
- They (can) make things easier
- They allows us to get explicit solutions (and quantify things)
- See the Appendix of Ch. 11 in Mankiw's textbook for a similar analysis to that below.

- We assume the IS and LM equations have the following form:

$$m^s - p = ky - \epsilon i$$

$$y = a + \delta (y - t) + h_0 - \gamma r + g$$

- **The parameters we have chosen measure the elasticities.**[4]
- In this course we will usually work with these types of equations.
    - Advantage - we can solve the model explicitly and find the multipliers for policy
    - Disadvantage - we may lose some intuition.

[4] Note: we have switched from (mostly) upper case to lower case letters.

Exogenous/Endogenous Variables and Parameters

$$i = \frac{1}{\gamma}\left[a - (1-\delta)\, y - \delta t + h_0 + g\right]: \text{ IS}$$

$$i = \frac{1}{\epsilon}\left[ky - (m^s - p)\right]: \text{ LM}$$

- **Endogenous:** i = interest rate and y = output.
- **Exogenous:** m^s = money supply, p = price level, a = autonomous consumption, t = taxes, h_0 = autonomous investment, g = government spending.
- **Parameters:** γ =interest elasticity of investment, $\delta < 1$ = MPC, ϵ = interest semi-elasticity of money demand, k = income elasticity of money demand.

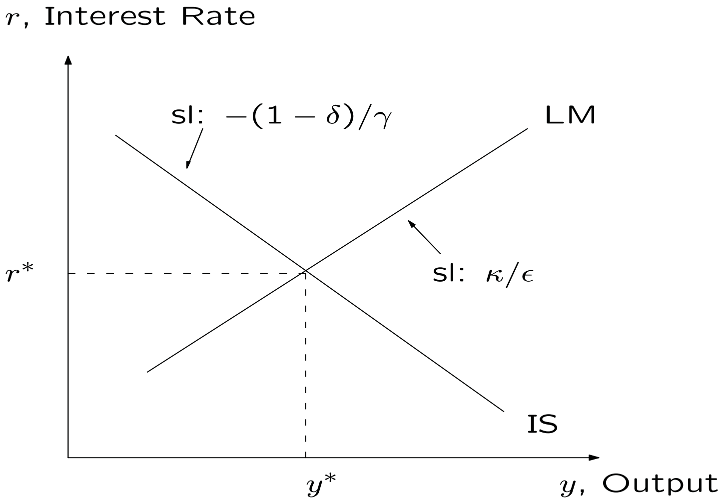
Parameter Restrictions and The Quantity Equation

- The velocity equation is usually written as $MV = PY$. In logs, $m - p = y - v$.
- The simplest case is V constant and equal to one. In that case,

$$m - p = y$$

- We can now see that our LM is a generalized version of this equation, with $\epsilon = 0$ and $k = 1$.
- For example, we can measure the impact of changes in the interest rate on liquidity by varying the interest elasticity of money demand, ϵ.

ISLM Equilibrium



Equilibrium

- With functional forms the solution to the ISLM model can be written in the following way:

$$y^* = \Omega \left[a - \delta t + h_0 + g + \frac{\gamma}{\epsilon} (m^s - p) \right]$$

$$\text{where } \Omega \equiv \left(1 - \delta + \frac{\gamma k}{\epsilon} \right)^{-1} > 0$$

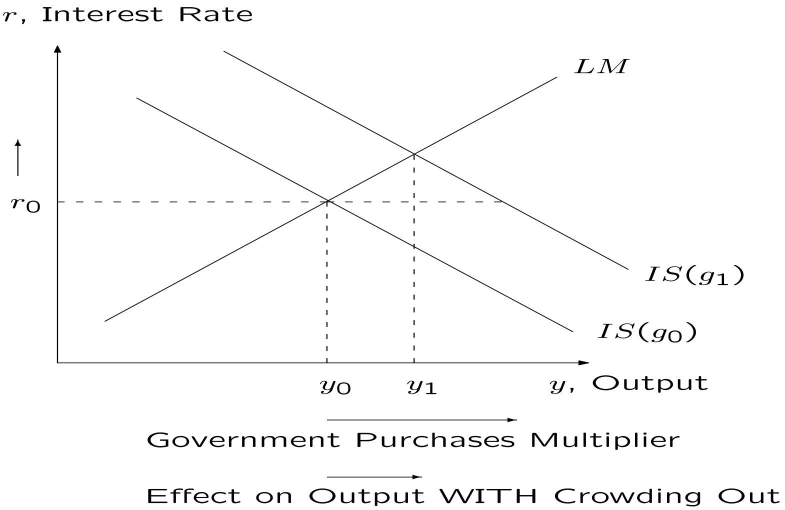
$$i^* = \frac{1}{\epsilon} \left[k y^* - (m^s - p) \right]$$

- Now we can see **exactly how monetary and fiscal policy affect output and the interest rate** and the significance of the elasticity assumptions.

Fiscal Policy: $\uparrow g$

- An increase in government spending raises output. But there are two mechanisms at work.
- Through the IS curve output goes up (this direct effect, via the Keynesian cross, is $1/\left(1-\delta\right)$).
- However, the interest rate goes up. And we know that reduces investment. This lowers output (an indirect effect).
- Overall, output rises by $\Omega = \left(1 - \delta + \frac{\gamma k}{\epsilon}\right)^{-1} < \left(1-\delta\right)^{-1}$. So, fiscal policy is said to **crowd out** investment.

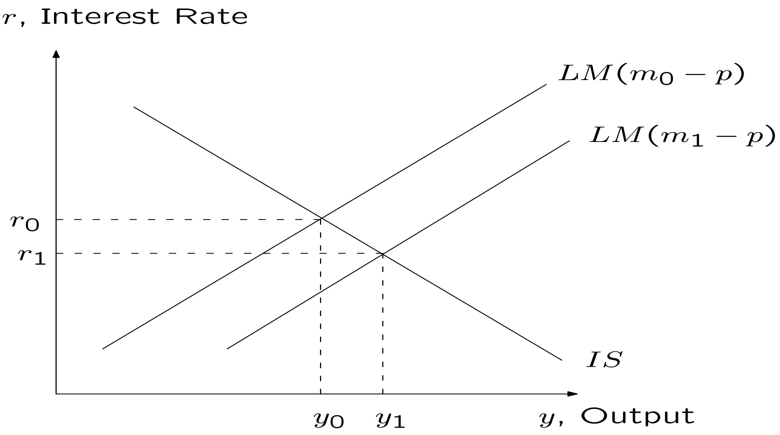
Fiscal Policy and Crowding Out



Monetary Policy: $\uparrow m^s$

- Suppose there is an increase in m^s.
- This implies $m^s > m^d$ at the current interest rate and so individuals prefer to buy bonds rather than hold this extra cash.
- However, i falls to clear the market such that people are happy to hold additional money balances and the money market returns to equilibrium at a lower interest rate.
- This impacts the goods market, as a reduction in i stimulates investment.
- This raises expenditures, and subsequently y.
- We call this the 'monetary transmission mechanism'.

Monetary Trnasmission Mechanism



Here $m_0 \rightarrow m_1$, where $m_0 < m_1$ and p is fixed.

Analytics

- The lowering of the interest rate by printing money is sometimes called the 'liquidity' effect.
- The effect on output of policy is given by:

$$\Delta y^{*}/\Delta m^{s} = (\gamma/\epsilon)\,\Omega > 0$$

- The change in the interest rate is:

$$\begin{aligned}\Delta i^{*}/\Delta m^{s} &= \frac{1}{\epsilon}\left[k\left(\Delta y/\Delta m^{s}\right) - 1\right] \lesseqgtr ? \\ &= -\left(1-\delta\right)/\left[\left(1-\delta\right)+\gamma k\right] < 0\end{aligned}$$

- Mechanism: Δm^{s}, $p = \overline{p} \rightarrow \Delta i \rightarrow \Delta I \rightarrow \Delta y$.

Fiscal vs. Monetary Policy

- Another question we can now ask - what are the relative powers of fiscal and monetary policy on output?
- Since we have adopted functional forms we can answer this type of question.

$$\frac{\Delta y^* / \Delta g}{\Delta y^* / \Delta m^s} = \frac{\Omega}{(\gamma/\epsilon)\,\Omega}$$

$$= \frac{\epsilon}{\gamma} = \frac{\text{interest elasticity of money demand}}{\text{interest elasticity of investment}}$$

- If $\epsilon > \gamma$, then fiscal policy (as studied here) is more effective than monetary policy.

On Keynesian vs. Monetarists

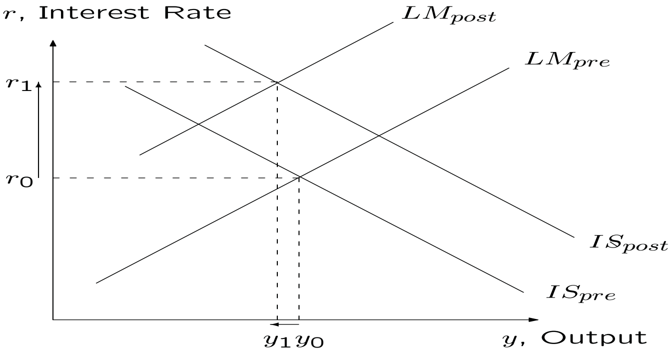
- What do **Keynesians** think (roughly): ϵ is large and γ is small (poss. 'animal spirits') $\Rightarrow$ **fiscal policy is more important**.
- What do **Monetarists** think (roughly): the opposite! They think ϵ is small, the LM is steep and **monetary policy is more important**.
- This makes knowing (i.e. estimating) the elasticities very important. But that turns out to be difficult.

1. data issues
2. stability of money demand over time.

Should we take this seriously?

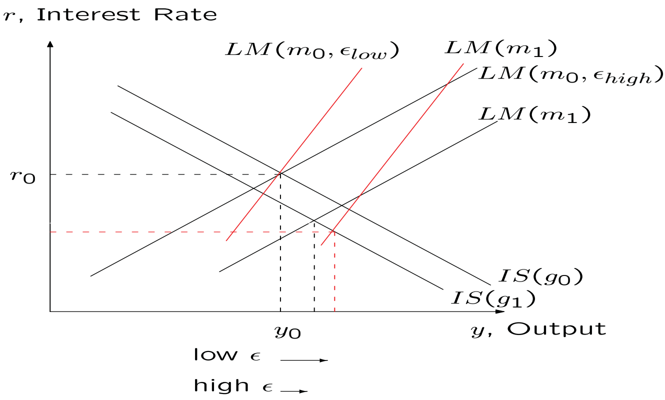
- We note that monetary policy may not be Δm^s. Central banks tend to use short-term interest rates.
- The same point holds for fiscal policy. We can interpret Δg as building roads or hospitals. However, fiscal policy is many other things (including changes in taxation).
- Also, we think of monetary policy as happening quickly (the central bank sets i in the UK once a month and it's effects last up to three years).
- Fiscal policy can take much longer to implement and be set permanently or temporarily (Obama's recent fiscal stimulus).

- Unification demands (i.e. a rise in g) alongside inflation fears kept in place by a monetary contraction (i.e. a fall in m)



Output Change: Ambiguous

- Fiscal consolidation (here, modeled as a drop in g) whilst the Fed tried to avoid the recession and allowed a 'monetary easing' (here, increase m).



Other Examples

- UK in the early 1980s:
  - Thatcher govt. elected in 1979. 'Right-wing' policies of fiscal prudence and anti-inflation policies.
  - This caused a large recession in the UK.
- US in early 2000s:
  - George W. Bush's large tax cuts and relatively lax monetary policy
  - Complicated by the US economy borrowing heavily from abroad to maintain high consumption levels.
- Not brave enough to comment on the Irish situation!

Recap

- We built an ISLM model based on Keynesian Cross and Money and Bond market equilibrium.
- We used it to study Fiscal (and crowding out) and Monetary Policy.
- It helps to clarify the policy options and potential pitfalls.
- But - what about the difference between real and nominal interest rates? What role does that play, if any?

Fisher Equation

- **Nominal Interest Rate** is the interest rate expressed in units of money (i_t)
- It tells us how much money we have to pay in the future in exchange for having one more unit of money today $(1 + i_t)$
- **Real Interest Rate** is the interest rate expressed in terms of a basket of goods (r_t)
- It tells us how many goods we have to give up in the future in exchange for having one more basket of goods today $(1 + r_t)$
- The real interest rate is important since agents consume goods and not money.

Nominal and Real Interest Rates

- Suppose you borrow money today to buy a good of price P_t. Then you have to repay $(1 + i_{t+1})P_t$ next year.
- In terms of goods (real terms), next period, you need to deflate by what you expect the price level to be. That is, P_{t+1}^e.
- Thus, you expect to payback, in real terms,

$$(1 + i_{t+1})\frac{P_t}{P_{t+1}^e}$$

- It follows that the one-year real interest rate is,

$$(1 + r_{t+1}) = (1 + i_{t+1})\frac{P_t}{P_{t+1}^e}$$

Nominal and Real Interest Rates

- Expected inflation is defined as

$$\pi^e_{t+1} = \frac{P^e_{t+1} - P_t}{P_t}$$

- We find:$(1 + r_{t+1}) = (1 + i_{t+1}) \,/\, \left(1 + \pi^e_{t+1}\right)$. But if i_{t+1} and π^e_{t+1} are small, then,

$$(1 + i_{t+1}) \,/\, (1 + \pi^e_{t+1}) \approx 1 + i_t - \pi^e_{t+1}$$

and,

$$r_{t+1} = i_{t+1} - \pi^e_{t+1}$$

- This is the **Fisher Equation**.

Ex-ante and ex-post real interest rates

- The real interest rate actually captures two periods. This is reflected in P_t and P^e_{t+1}.
- When we borrow/lend we don't know what inflation will be over the period.
- This leads to two concepts of the real interest rate (dropping t's).

1. r when the loan is made (or r^e): *ex-ante* rate: $r^e = i - \pi^e$
2. r once the inflation rate is realized: *ex-post* rate: $r = i - \pi$

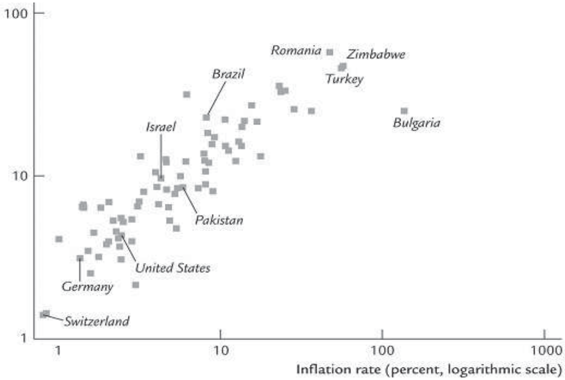
- These will only be the same if our expectation is correct.

Implications of the Fisher Equation

- We distinguish three cases:
- $\pi^e = 0 \Rightarrow r = i$ (used above)
- $\pi^e > 0 \Rightarrow r < i$
- $\pi^e = i \Rightarrow r = 0$

1. Notice that $i \geq 0$ (referred to as the **Zero Lower Bound**) but $r \lesseqgtr 0$. US has recently had $r < 0$.
2. **Fisher Hypothesis:** nominal interest rate changes one-for-one with the rate of change of the money supply (no effect on the real interest rate).

Fisher Effect (Source: Mankiw)



- i is on the vertical axis and inflation responds 1-for-1 with the growth in the money supply.

The ISLM Model and the Fisher Equation

- We use the same model as before - we eliminate r from the IS using the Fisher equation.

$$m^s - p = ky - \epsilon\left(r + \pi^e\right)$$

$$y = a + \delta\left(y - t\right) + h_0 - \gamma r + g$$

- We assumed that expectations are exogenous. What happens if expectations change?
- There are real effects, that is, output changes. Expected inflation influencing output is called the Mundell-Tobin effect.

The US Depression - 1930s

- Since the decline in income in 1930's coincided with falling interest rates some suggest there was a contractionary shift in the IS curve.
- **Causes:**

1. A downward shift in the consumption function (i.e., the $C(Y-T)$ part of the Keynesian cross)?
2. A large drop in housing investment? - there was a residential investment boom in the 1920s $\Rightarrow$ overbuilding.
3. Amplification: banks also failed. Bad loans were made and not paid back. This lowered investment demand and loans to businesses.

Japan's Liquidity Trap (most of the 1990s)

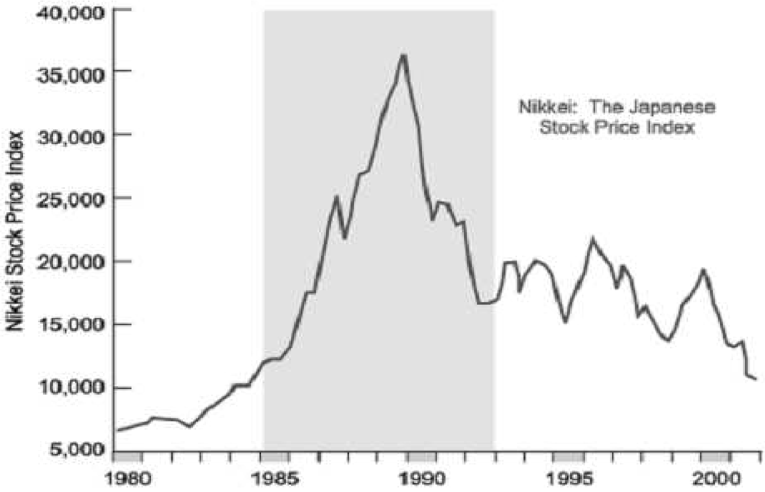
- Keynes argued that during a depression, such as the US in the 1930s, monetary policy would be ineffective at influencing aggregate demand.
- Why?
  - Monetary Policy works by lowering the nominal interest rate.
  - However, we know that there is a zero lower bound problem, that is, $i \geq 0$.
  - If output is very low (i.e. in a depression) we can't keep reducing the nominal interest rate.
- Paul Krugman suggested the same thing happened in Japan in the 1990s.

Some more details on Japan

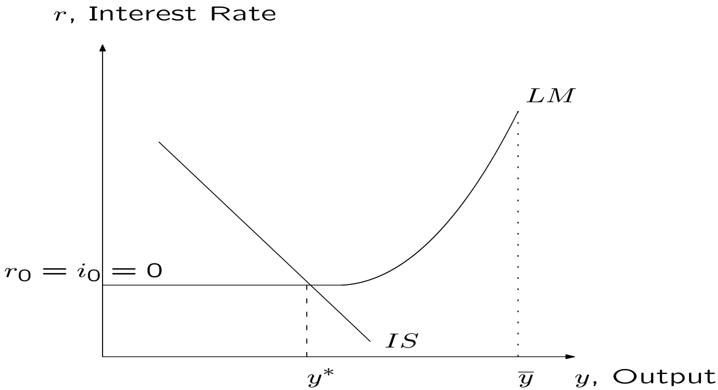
- In the 1980's the Japanese economy was booming. However, there was a stock market bubble.

1. Eventually there was a drop in stock prices and the wealth of individuals dropped significantly.
2. Banks, trying to make profits, had lent to risky companies. They failed and this magnified the effect of the stock price fall (a 'credit crunch').
3. We might think of this as a shock (negative) hitting the IS curve, via investment and consumption.
4. This also coincided with a low interest rate period.

The NIKKEI Index



Liquidity Trap in the ISLM Model



... where $\overline{y}$ is Full Employment

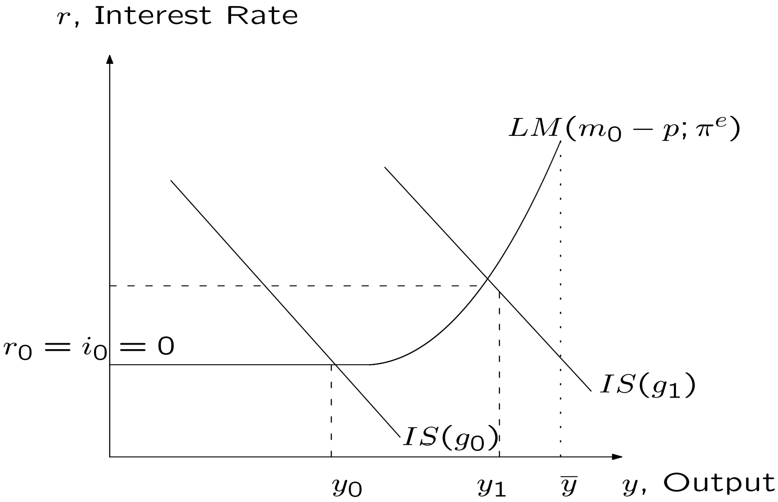
- Japan hit $i_t = 0$. People also thought $\pi_t^e = 0$ or slightly positive. Then $r_t \simeq 0$, by the Fisher equation.

Policy Recommendations

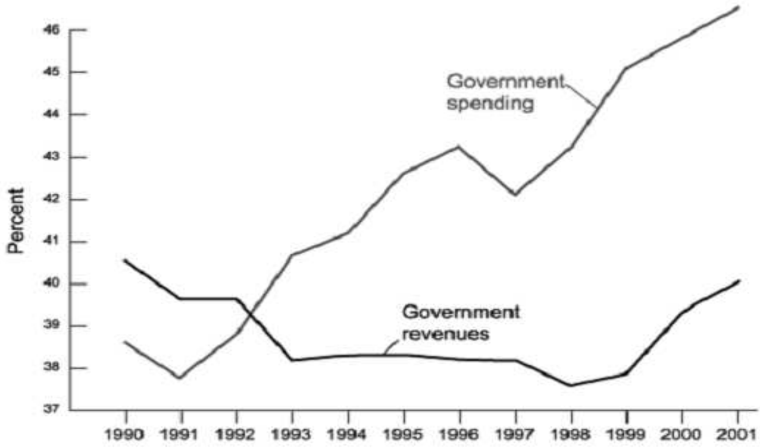
- We have a recession situation (i.e. $y^* < \overline{y}$) and there are a limited number of policy options.

1. Massive Fiscal Expansion
2. Create Inflation Expectations (i.e. $\pi^e > 0$)
3. Large $\uparrow m$ could boost trade, via the exchange rate (we haven't covered this yet)

Fiscal Policy Revisited



Fiscal Policy in Japan



Monetary/Quantitative Easing

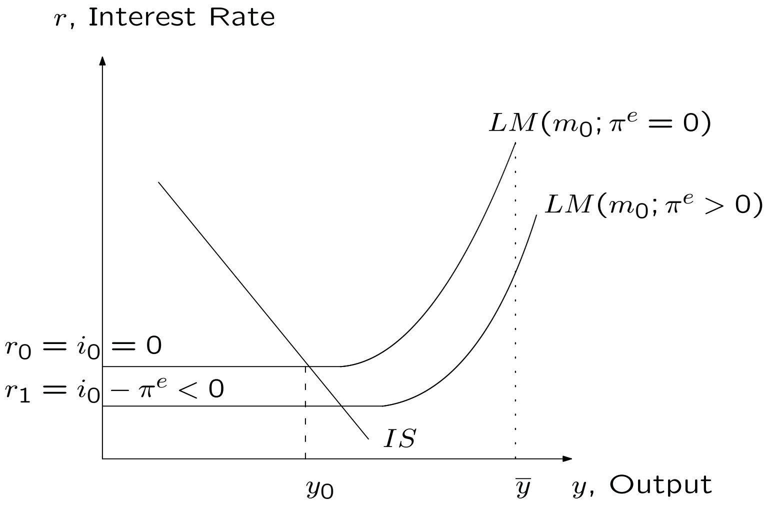
- Japan did also attempt to stimulate the economy via monetary policy, a policy called "quantitative monetary easing" - essentially this involved trying to boost liquidity in financial markets.
- This did have some (limited) impact.
- However, by then, expectations we fixed at $\pi^e \simeq 0$.
- So, what if we could somehow alter π^e?

'Unusual' Monetary Policy

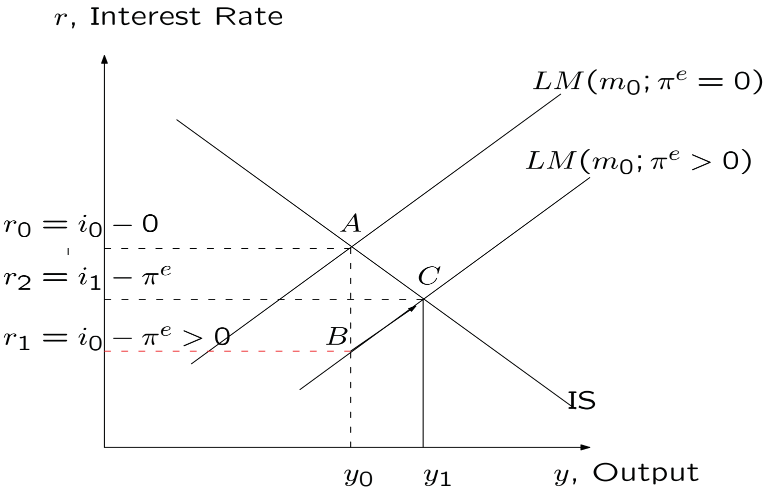
- How is all of this relevant for today? In 2000s we saw globally low interest rates, which lead to a bubble. There was also excess lending by banks. Similar to Japanese problem. Now the UK is using QM. As is the Eurozone and Fed.
- Alternative ideas:

1. One other (unusual) option is to attempt to raise π^e. For a given i, the real interest rate will fall, boosting investment. However, π^e is endogenous. We have assumed it is exogenous. So this solution creates other problems
2. **Another idea put forward - along the same lines - is that** π^e can also affect output because the nominal interest rate rises less than one-for-one with the rate of change of the money supply (contradicts the Fisher Hypothesis) as agents change money for bonds (i.e. portfolio reallocation), itself altering the interest rate.

Manipulating Inflation Expectations



Mundell-Tobin Effect



Roundup

- Investment demand and Keynesian cross
- IS curve
- Money market and LM curve
- Fiscal and monetary policy
- Liquidity trap