International Monetary Policy 7 IS-LM Model ¹

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Lecture topic and references

- In this lecture we construct a simple macroeconomic model that helps understand what happens after monetary policy contractions and expansions
- Mishkin, Chapter 20

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Review from previous lecture



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We need some theory

- So far we have learnt how Central Banks behave. What we need now is some understanding of the impact of monetary policy on the entire economy
- The model we will study in this lecture helps predict the impact of both monetary and fiscal policies, at least in the short run when prices are fixed
- We will start by constructing the model, which is a simple reduced-form model of 2 equations in 2 unknowns. Afterwards, we will use it for some policy analysis

The IS-LM model in a Nutshell

- The IS-LM model is the theoretical synthesis of the Keynesian way of thinking about macroeconomics
- It reflects what Keynes had in mind when he wrote *The General Theory of Employment, Interest, and Money*, published in year 1936. But the model was formalized by Sir John Hicks in year 1937

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The IS-LM model in a Nutshell

- The key intuition is that aggregate output/production/income (they are the same) reflect the equilibrium between aggregate demand (by market players) and aggregate supply (by firms)
- To the extend that policymakers can influence aggregate demand, aggregate supply will follow and the economy will move towards a desired equilibrium (at least in the short run)

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- Let's start with a simplified version of the model, where the only market considered is the goods market (we will introduce the money market shortly)
- By aggregate supply Y^{as} we mean the total production of goods in an economy. It clearly comes from firms
- Aggregate demand comes instead from a variety of economic players. In general:

$$Y^{ad} = C + I + G + CA$$

with

- C = Consumption
- I = Investment
- G = Government Spending
- NX = Net Exports

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The equilibrium in the goods market will be given by an effective level of production Y where

$$Y^{as} = Y^{ad} = Y$$

- The point of the model is to determine the level of output Y* so that the corresponding aggregate demand Y^{ad} is exactly equal to Y*
- In order to do this we need to come up with some theory of the components of aggregate demands, and then derive the equilibrium

• Start from the simplified case where G = NX = 0

• Assume
$$C = a + mpc \cdot Y^d$$
, where

- a = autonomous consumer expenditure
- mpc = marginal propensity to consume (between 0 and 1)
- Y^d = disposable income = Y T (here T=0)
- ▶ Assume for the moment that investments by firms are determined exogenously (i.e. not inside the model), i.e. $I = I_0$ (we will abandon this restrictive assumption shortly)

• This means that
$$Y^{ad} = a + mpc \cdot Y + I_0$$

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- The key intuition is that aggregate demand depends positively on output, so there will be only one level of output whose corresponding aggregate demand is exactly equal to that output
- In order to characterize that level of output one can proceed in two ways:
- Approach a): Solve for the reduced form of Y after imposing Y = Y^{ad}

$$Y = a + mpc \cdot Y + I_0$$

Solving for Y one gets

$$Y^* = \frac{1}{1 - mpc} \cdot (a + l_0) \tag{1}$$

• Note, $\frac{1}{1-mpc} > 1$

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- ▶ Before interpreting the above result, let's see the other approach:
- ► Approach b): Compare graphically Y^{ad} and Y
- Note, on the space (Y^{ad}, Y) the function Y^{ad} is a line with intercept a + I₀ and slope mpc
- What happens if I₀ increases by 1? Graphically, the Y^{ad} shifts up; analytically, equation (2) shows that

$$\Delta Y^* = rac{1}{1-mpc} \Delta I_0$$

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- How is it possible that an increase in the exogenous investment by 1 increase equilibrium output by more than 1?
- The intuition is the following: as firms demand for one extra good, some other firm will produce that extra good
- This means that some consumer will earn a higher disposable income, since the profits (or simply the wage) from producing that extra good must go somewhere. As consumption increases, aggregate demand increases again, triggering the same mechanism
- ▶ This mechanism is called multiplication process. For this reason we call $\frac{1}{1-mpc}$ the *expenditure multiplier*

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Introducing Government Expenditure

- Let's abandon now the restrictive assumption that there is no government expenditure
- ▶ Assume $G = G_0$. Under balanced budget we have G = T, hence $Y^d < Y$

Introducing Government Expenditure

In this new setting aggregate demand will be given by

$$Y = a + mpc \cdot (Y - T) + I_0 + G_0$$

Solving for Y one gets (substituting G = T)

$$Y^* = \frac{1}{1 - mpc} \cdot (a + I_0 + (1 - mpc) \cdot G_0)$$
 (2)

Note that the multiplier on the government expenditure is 1. Let's see this graphically

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Aggregate Demand with Government Spending



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Aggregate Demand with Government Spending

- When government expenditure increases by 1 the government is increasing taxes by 1. How can it be that equilibrium output still increases, given that what the government gives is equal to what it takes away?
- ▶ The point is that an extra unit of government expenditure increase aggregate demand by 1, while an increase in taxation by 1 decreases aggregate demand *mpc* < 1, so that, on impact, aggregate demand increases and starts the multiplication mechanism described before
- Under constant interest rate (as in this case) the fiscal multiplier is

$$\frac{\Delta Y^*}{\Delta G} = 1$$

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Exercise 1 on Aggregate Demand

- Suppose that a = 2, mpc = 0.5, $I_0 = 10$ and there is no government. Show the equilibrium condition graphically and compute the equilibrium output. What is the value of aggregate demand in equilibrium?
- Suppose that the exogenous investments increase up to 15. What do you expect to happen to equilibrium output? Do the above steps and check your prediction

Exercise 2 on Aggregate Demand

- Suppose that a = 2, mpc = 0.5, l₀ = 10. The government runs a balance budget equal to 10. Show the equilibrium condition graphically and compute the equilibrium output. What is the value of aggregate demand in equilibrium?
- Suppose that government expenditure increases by 2. What do you expect to happen to equilibrium output? Do the above steps and check your prediction

- So far we have assumed that investments are exogenous, that is, depend on so called animal spirits
- If we think about it, it makes sense to assume that investments are negatively related to the interest rate

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- Remember, by investments we mean, for instance, firms deciding to buy a new machinery for their production
- In doing so firms need to borrow money from savers, and will issue bonds with a contractual interest rate
- The higher is the interest rate and the higher the cost of money, hence the lower the incentive to invest (net present value of future cash flows decreases)

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Assume that investments have an exogenous component I₀ and an endogenous component that depends negatively on the interest rate, according to a factor b

$$I = I_0 - b \cdot r$$

Under this new environment aggregate demand is given by

$$Y = a + mpc \cdot (Y - T) + I_0 - b \cdot r + G_0$$

Following the same steps we get

$$Y^* = \frac{1}{1 - mpc} \cdot (a + l_0 - b \cdot r + (1 - mpc) \cdot G_0)$$
(3)

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- Note, equilibrium output Y* is negatively related to the interest rate, as clearly displayed by (3). This is because a higher interest rate would reduce investments, decrease aggregate demand and hence equilibrium output
- Equation (3) provides one of the two key equations of the model
- So far the only endogenous variable was Y, which was representing the equilibrium variable for the goods market. But a monetary model of course considers the interest rate as well as an endogenous variable

 We will derive the second equation after we introduce the money market

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IS Curve

Let's rewrite (3) in a more convenient form. We will refer to this as the *IS curve*

$$Y^* = \frac{1}{1 - mpc} \cdot (A - b \cdot r) \tag{IS}$$

with $A = a + l_0 + (1 - mpc) \cdot G_0$, defined as the autonomous aggregate demand

► The IS curve is defined as the combination of (r, Y) where the goods market is in equilibrium. Any disequilibrium will be eliminated by variations in output

IS Curve

- ► The IS curve is negatively sloped on the the space (r, Y): higher interest rate reduces investments, aggregate demand and hence equilibrium output
- Above the curve we have excess supply of goods; equilibrium output will decrease since firms realize that they are producing too much
- Below the curve we have excess demand of goods; equilibrium output will increase since firms realize that they are producing too little

IS Curve



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Exercise 1 on IS curve

Consider the following figure and complete the next slide:



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Exercise 1 on IS curve

- ► The level of output so that, at r = 2%, the aggregate demand coincides with output, is 12/15/18 (?)
- At r = 2%, if firms produce 12 the economy is experiencing an excess demand/supply (?) of goods
- In order for 12 to be an equilibrium output, the economy needs a higher/lower interest rate, in order to increase/decrease (?) private investments

- Money supply is provided by the Central Bank. We have seen that its control is not perfect, as there are important factors affecting money supply that depend on market participants
- ► In this model we assume that money supply is perfectly controlled by the CB. Call M^s the nominal amount of money
- ▶ It follows that the real amount of money supply will be given by

 $\frac{M^s}{P}$

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- How do we pin down real money demand?
- Transaction motive: people demand money for doing transactions, so the higher output and the higher money demand
- At the same time people might decide to allocate their wealth into assets, instead of money

- There is a clear trade off: money is by definition liquid, so can be used for transaction. But it yields no interest rate
- Speculative motive: The higher the interest rate and the higher the incentive to shift from money to assets. The higher the interest rate and the lower the real money demand

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- Remember, we saw that on the goods market an increase in interest rate reduces investments. This was because firms will have to pay such interest rate
- The point is that savers are on the other side: they will earn the interest rate as soon as they decide to allocate part of their wealth to assets
- Do not confuse the idea of investment with the allocation of savings into financial instruments. Investment means physical investments

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- Having established a money demand and a money supply, we only need to impose equilibrium and pin down the second equation of the model
- Write money demand as

$$M^d = L(\underline{Y}, \underline{r})$$

where the signs under Y and r indicate partial derivatives

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Imposing equilibrium on the money market gives

$$\frac{M^s}{P} = L(\underbrace{Y}_+, \underline{r}) \tag{LM}$$

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The above equation capture the LM curve: combinations of income and interest rate that allow for the equilibrium in the money market

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- One can study the LM curve either on the (r, M) space or on the (r, Y) space
- On the (r, M) space the Real Money Supply is vertical, while the Money Demand is negatively sloped

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- A situation of excess money supply will lead to a reduction of the cost of money: firms will find it easier to issue bonds as the market is full of liquidity, so will pay a lower interest rate
- Similarly, a situation of excess money demand will lead to an increase in the cost if money: firms issuing bonds will struggle to raise funds and will have to increase the interest rate paid

Disequilibrium in the Money Market



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Disequilibrium in the Money Market



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- Note: as income increases, money demand shifts to the right. This creates an excess of money demand and a consequent increase in the interest rate. This means that the LM curve implies a positive relation between Y and r
- Note: the movement in the interest rate allows the market to move back to equilibrium. In case of excess of money demand (supply) interest rate will increase (decrease), hence reducing (increasing) money demand and leading the money market to equilibrium

Money Market: Y and r are positively related



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- ▶ How does the LM curve look like on the (r, Y) space?
- It is positively sloped: an increase in income increase money demand. Given that money supply is exogenous, we need an increase of the interest rate to decrease money demand and guarantee the equilibrium on the money market
- The adjusting variable on the money market is the interest rate (on the goods market it was output)

LM curve



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Exercise 1 on LM curve

Consider the following figure and complete the next slide



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Exercise 1 on LM curve

Assume nominal Money Supply equals 20, level of prices equals 2. Then

- At point A Money Demand (= / > / <)10, interest rate will increase /decrease/stay constant (?)
- At point B Money Demand (= / > / <)10, interest rate will increase /decrease/stay constant (?)
- At point C Money Demand (= / > / <)10, interest rate will increase /decrease/stay constant (?)
- At point D Money Demand (= / > / <)10, interest rate will increase /decrease/stay constant (?)

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The IS - LM Model

- Let's sum up: the IS-LM model studies the equilibrium in two markets, the goods market and the money market
- The endogenous variables are income Y and the interest rate r
- The equilibrium conditions are captured by two curves, the IS curve and the LM curve
- Output / interest rate adjustment allow the system to reach an equilibrium where both markets clear

IS - LM Model



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What happens in point A ?



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Adjustment Mechanisms

- Since goods market is in equilibrium, output will not change. But the excess demand of money will lead to an increase in the interest rate, which starts closing the gap of excess money demand (point B)
- As interest rate increases the goods market gets out of equilibrium: incentive to invest have decreased, so aggregate demand has fallen, but aggregate output has not. This will lead firms to decrease production (point C)
- The mechanism continues until the economy reaches point E

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Adjustment Mechanisms



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What happens in point A ?



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Adjustment Mechanisms

- Since money market is in equilibrium, interest will not change. But the excess supply of goods will lead firms to reduce production, which starts closing the gap on the goods market (point B)
- As output decreases the money market gets out of equilibrium: demand for money decreases due to reduced transaction motive, pushing interest rate to fall (point C). Note that the fall in *r* increases investment and closes the gap on the goods market
- The mechanism continues until the economy reaches point E

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Adjustment Mechanisms



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Plan for the Future

- Economic policies will shift the IS and / or LM curve
- Use the model to understand the impact of different economic policies on the equilibrium of the economy
- After covering International Economics we will reframe the model to allow for NX different than zero