International Monetary Policy

13 IS-LM Model in Open Economy

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Lecture topic and references

- In this lecture we extend the IS-LM model to an open economy and understand the different effectiveness of economic policies across different monetary regimes

- No reference, sorry
Review from previous lecture

- Under fixed exchange rates we have

\[ BP > 0 \rightarrow D_{dc} > S_{dc} \text{ i.e. } D_{fc} < S_{fc} \rightarrow Dc \text{ would appreciate} \rightarrow \]
\[ \rightarrow IR \uparrow \rightarrow MB \uparrow \rightarrow M^s \uparrow \]

\[ BP < 0 \rightarrow D_{dc} < S_{dc} \text{ i.e. } D_{fc} > S_{fc} \rightarrow Dc \text{ would depreciate} \rightarrow \]
\[ \rightarrow IR \downarrow \rightarrow MB \downarrow \rightarrow M^s \downarrow \]
IS curve in Open Economy

- Remember, equilibrium on the goods market requires
  \[ Y^{as} = Y^{ad} \]

- We defined aggregate demand as
  \[ Y^{ad} = C + I + G + CA \]

  with
  - \( C = \text{Consumption} \)
  - \( I = \text{Investment} \)
  - \( G = \text{Government Spending} \)
  - \( CA = \text{Current Account} \)
What we need to do is assume some meaningful expression for CA

We saw that $CA = X - IM$, and we assumed

$$X = X(\epsilon)$$

$$IM = IM(\epsilon, Y)$$

Given the real exchange rate as a measure of domestic goods competitiveness, exports increase as the domestic currency depreciates. Imports increase as the domestic currency appreciates, and increase if the domestic economy has a higher national income.
IS curve in Open Economy

- It follows that the net export increases as the domestic currency depreciates and decreases as the domestic economy increases in output.\(^2\) Specifically, we will assume

\[
CA(\epsilon, Y) = X_0 + x \cdot \epsilon - z \cdot Y
\]

- Note, CA increases as domestic currency depreciates, and as Y increases

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\(^2\)To be precise, this is not always the case, since there are both price and income effects: as the domestic currency depreciates the price of imports increases, so CA moves temporarily into deficits until quantities imported decrease and quantities exported increase. We will assume that the Marshall-Lerner conditions are satisfied, so that the current account increase as the domestic currency depreciates. Don’t worry about this.
IS curve in Open Economy

- At this point we simply need to derive the new IS curve

\[ Y = a + mpc \cdot (Y - T) + l_0 - b \cdot r + G_0 + X_0 + x \cdot \epsilon - z \cdot Y \]

- Factorizing \( Y \) we obtain

\[ Y^* = \frac{1}{1 - mpc + z} \cdot (a + l_0 - b \cdot r + (1 - mpc) \cdot G_0 + X_0 + x \cdot \epsilon) \]
IS curve in Open Economy

- Rewrite the above expression in a more convenient form and obtain the IS curve in Open Economy

\[ Y^* = \frac{1}{1 - mpc + z} \cdot (A - b \cdot r + x \cdot \epsilon) \quad \text{(IS)} \]

with \( A = a + l_0 + (1 - mpc) \cdot G_0 + X_0 \), defined as the autonomous aggregate demand in open economy.
IS curve in Open Economy

▶ Note, under closed economy the IS curve was defined as the combinations of interest rate and output that guarantee equilibrium on the goods market

▶ The key difference here is that we have an extra variable, the real exchange rate! As $\epsilon$ increases the domestic currency depreciates, net exports increase and the aggregate demand increases

▶ Similarly, as $\epsilon$ decreases the domestic currency appreciates, net exports decrease and the aggregate demand decreases
IS curve in Open Economy

- This means that here we define the IS curve as the combinations of interest rate, output and real exchange rate so that the goods market is in equilibrium.

- Having three variables instead of two, how do we represent the curve graphically?

- It turns out that it is convenient to represent it on the \((r, Y)\) space and to parametrize the curve at different possible values of \(\epsilon\).
For each level of the exchange rate, the IS curve is negatively sloped on 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 in Open Economy

Excess Supply

\[ Y^s > Y^d : Y \text{ down} \]

Excess Demand

\[ Y^s < Y^d : Y \text{ up} \]

IS(\(\varepsilon\_low\))
For given level of interest rate, a higher level of $\epsilon$ means that the current account is higher as the domestic currency is depreciated.

Hence equilibrium output will be higher, otherwise there would be an excess demand in the goods market.
IS curve in Open Economy
LM curve in Open Economy

- Nothing is different in the derivation of the LM curve. Remember, we had
  \[ \frac{M^s}{P} = L(Y, r) \] (LM)

- The *LM curve* captures all combinations of income and interest rate that allow for the equilibrium in the money market.

- There is going to be a unique key difference here. Under fixed exchange rate the nominal money supply cannot be any given value, but must be the one that guarantees the equilibrium in the exchange rate. We will get back to this point.
**LM curve**

Excess Supply

\[ \frac{M^s}{P} > M^d : r \text{ down} \]

Excess Demand

\[ \frac{M^s}{P} < M^d : r \text{ up} \]
BoP Equilibrium

- What we are missing is an equilibrium condition for the third market considered by the model, the forex market.

- We saw that the forex market is in equilibrium when the current account and the capital account sum up to zero.

- When BoP > 0, it means that the overall demand for domestic currency exceeds the overall supply for domestic currency, leading to an exchange rate appreciation.

- When BoP < 0, it means that the overall demand for domestic currency runs short of the overall supply for domestic currency, leading to an exchange rate depreciation.
BoP Equilibrium

▶ Remember, BoP = CA + KA = \Delta \cdot IR

▶ In our model, CA = X_0 + x \cdot \epsilon - z \cdot Y

▶ Assume that the capital account is uniquely determined by the interest rate spread between the two countries according to the factor \theta. This implies

\[
\text{BoP} = X_0 + x \cdot \epsilon - z \cdot Y + \theta \cdot (r - r^w) = \Delta \cdot IR
\]

where \(r^w\) is equal to the world interest rate
The forex market is in equilibrium when the combination of $\epsilon, r, Y$ is so that

$$X_0 + x \cdot \epsilon - z \cdot Y + \theta \cdot (r - r^w) = 0$$

Having represented the IS curve on the $(r, Y)$ space, it is convenient to do the same for the BoP curve.
BoP Equilibrium

- Factorize the interest rate to recover the BoP curve:

\[ r = r^w + \frac{1}{\theta} \cdot (z \cdot Y - X_0 + x \cdot \epsilon) \]  

(BoP)

- This expression detects the BoP curve: combinations of exchange rate, interest rate and output so that the forex market is in equilibrium

- The BoP curve is positively sloped on the \((r, Y)\) space: an increase in the interest rate determines a higher capital inflow and a higher demand for domestic currency. Holding the exchange rate constant one needs a higher equilibrium output to increase imports, increase supply of domestic currency and avoid exchange rate movements
BoP Equilibrium

Excess Demand of Domestic curr.

BoP > 0, need Y up to increase import
or r down to decrease K inflow

Excess Supply of Domestic curr.

BoP < 0, need Y down to decrease import
or r up to increase K inflow
The BoP curve is parametrized at different values of the exchange rate: given an interest rate, higher values of $\epsilon$ imply a higher level of equilibrium output.

This is because, given the interest rate, the demand and supply of currency from the capital account is unchanged. As the domestic currency depreciates we have a disequilibrium in the forex market resulting from the increase in net exports. To offset this we need an increase in output to boost imports and hence the supply of domestic currency.
BoP Equilibrium
BoP Equilibrium

- We will consider only the special case of Perfect Capital Mobility: there is no friction in the international capital flows, so that any difference in the interest rates across countries causes capital inflows of infinite amount.

- This coincides with taking the limit of the parameter $\theta$ up to infinity. The BoP curve becomes

$$ r = r^w \quad \text{(BoP)} $$
BoP Equilibrium

- Note, this means that the equilibrium in the forex market is determined uniquely by the capital account. Any minimum spread between domestic and foreign interest rates creates excesses of demands and supplies that cannot be matched by any current account position.

- This means that in equilibrium the domestic interest rate must coincide with the foreign interest rate. The capital inflows and outflows that take place in equilibrium are the ones required to balance the current account position (investors are perfectly indifferent between investing in the domestic or in the foreign country).
BoP Equilibrium under Perfect Capital Mobility
The IS-LM Model in Open Economy

- To sum up, the model studies three markets, goods, money and exchange markets.
- Hence, it has three variables, respectively output, interest rate and exchange rate.
- The model is hence given by three equations in three unknowns.
The IS-LM Model in Open Economy

- **IS curve**

\[ Y^* = \frac{1}{1 - mpc + z} \cdot (A - b \cdot r + x \cdot \epsilon) \]  
\hspace{1cm} \text{(in \ (Y,r, \epsilon))}

- **LM curve**

\[ \frac{M^s}{P} = L(Y, r) \]  
\hspace{1cm} \text{(in \ (Y,r))}

- **BoP curve**

\[ r = r^w \]  
\hspace{1cm} \text{(in \ (r))}

- The equilibrium interest rate is always pinned down by the BoP curve. The determination of the remaining variables depends crucially on the exchange rate regime.
Flexible Exchange Rates

- Under flexible exchange rate, the exchange rate is an endogenous variable determined by market forces. Money is exogenously determined, as it simply reflects the monetary stance that the CB follows.

- Solve the model recursively:

  1. Determine $r^*$ from the BoP curve
  2. Given $r^*$ and $M^s$, determine $Y^*$ from the LM curve
  3. Given $r^*$ and $Y^*$, determine $\epsilon^*$ from the IS curve

- Let's see this graphically
Flexible Exchange Rates

\[ r \]

\[ r_w \]

\[ Y^* \]

\[ Y \]

\[ LM(M^s) \]

\[ \text{BoP} \]
Flexible Exchange Rates

\[ r \]

\[ r_w \]

\[ Y^* \]

\[ Y \]

\[ LM(M^s) \]

\[ IS(\varepsilon^*) \]

\[ BoP \]
Monetary Policy under Flexible Exchange Rates

- What happens if the CB increases money supply?

- The LM curve shifts right, the money market is now in disequilibrium and the excess of money supply generates a decrease in the interest rate

- While increasing investments, the reduction of the interest rate causes a capital outflow due to the lower return offered by domestic saving possibilities
Monetary Policy under Flexible Exchange Rates

- The capital outflow triggers a depreciation in the domestic currency, shifting the IS curve to the right.

- The overall increase in output increases money demand, leading the interest rate back to $r^w$. The current account is undetermined, due to the combination of higher domestic input and depreciation.

- Monetary policy is even more effective under flexible exchange rate, due to the effect on net exports.
Monetary Policy under Flexible Exchange Rates

\[ r \]

\[ r_{\text{w}} \]

\[ \text{LM}(M^{s}_{\text{low}}) \]

\[ \text{LM}(M^{s}_{\text{high}}) \]

\[ \text{BoP} \]

\[ \text{IS}(s^{\text{low}}) \]

\[ Y^{*} \]

\[ Y \]
Fixed Exchange Rates

- Under fixed exchange rate, the exchange rate is an exogenous variable determined by the CB (call it $\epsilon'$). Money is endogenously determined, as it the money supply that the CB must guarantee using international reserves interventions to stabilize the exchange rate at the desired level.

- Solve the model recursively:

  1. Determine $r^*$ from the BoP curve
  2. Given $r^*$ and $\epsilon'$, determine $Y^*$ from the IS curve
  3. Given $r^*$ and $Y^*$, determine $M^s$ from the LM curve

- Let's see this graphically
Fixed Exchange Rates

\[ IS(\varepsilon^*) \]

\[ r_{\text{w}} \]

\[ r \]

\[ Y^* \]

\[ Y \]

\[ \text{BoP} \]
Fixed Exchange Rates

\[ r \]

\[ r_w \]

\[ Y^* \]

\[ Y \]

\[ LM(M^{s*}) \]

\[ IS(\varepsilon^*) \]

\[ BoP \]
Monetary Policy under Fixed Exchange Rates

- What happens if the CB increases money supply?

- The LM curve shifts right, the money market is now in disequilibrium and the excess of money supply generates a decrease in the interest rate.

- While increasing investments, the reduction of the interest rate causes a capital outflow due to the lower return offered by domestic saving possibilities.
Monetary Policy under Fixed Exchange Rates

- The capital outflow triggers a depreciation in the domestic currency. But the CB cannot accept this as it has committed to a fixed $\epsilon'$. 

- In response it will contrast the excess of demand of foreign currency by supplying its own international reserves to the forex market. By doing this it reduces the monetary base. The LM curve shifts back.

- Monetary policy is ineffective under fixed exchange rate. Under fixed exchange rate you loose one channel of economic policy.
Monetary Policy under Fixed Exchange Rates
Monetary Policy under Fixed Exchange Rates

\[ r \]
\[ r_w \]
\[ Y* \]
\[ Y \]
\[ LM(M^s*) \]
\[ LM(M^s_{high}) \]
\[ IS(e') \]
\[ E \]
\[ \Lambda \]
\[ BoP \]
How about fiscal policy? Start from the case of flexible exchange rates.

When $G$ increases the IS curve shifts to the right. This leads firms to produce more. At the same time the excess money demand produced by this will increase the interest rate.
Fiscal Policy under Flexible Exchange Rates

- As $r$ increases the inflow of capital will increase the international value of the currency through an appreciation of the domestic currency. This shifts the IS curve back through a decrease in the trade balance.

- Under a flexible exchange rate, the crowding out effect of fiscal policy is complete and it occurs through the contraction in net exports.
Fiscal Policy under Flexible Exchange Rates

\[ r \]

\[ r_w \]

\[ Y^* \]

\[ Y \]

\[ LM(M^s) \]

\[ IS(G_{\text{high}}, \epsilon_{\text{high}}) \]

\[ IS(G_{\text{low}}, \epsilon_{\text{high}}) \]
Fiscal Policy under Flexible Exchange Rates
Fiscal Policy under Fixed Exchange Rates

- Consider now the case of fixed exchange rates

- When G increases the IS curve shifts to the right. This leads firms to produce more. At the same time the excess money demand produced by this will increase the interest rate
Fiscal Policy under Fixed Exchange Rates

- As $r$ increases the inflow of capital will increase the international value of the currency through an appreciation of the domestic currency. The CB cannot accept this and will react by accumulating international reserves.

- This will increase the money supply and shift the LM curve to the right.

- Under a fixed exchange rate, the crowding out effect of fiscal policy is zero since monetary policy is used to avoid an increase in interest rate.
Fiscal Policy under Fixed Exchange Rates

\[ r \quad r_w \quad r_w \]

\[ \text{LM}(M^s) \]

\[ \text{IS}(G_{\text{high}}, \varepsilon^*) \]

\[ \text{IS}(G_{\text{low}}, \varepsilon^*) \]

\[ \text{BoP} \]

\[ Y^* \quad Y \]
Fiscal Policy under Fixed Exchange Rates