Open Economy IS/LM Model

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Objectives

In this section you will learn

1. how to extend the IS-LM model to an open economy
2. how to analyze monetary and fiscal policy in an open economy
3. why the Central Bank loses control over the money supply under fixed exchange rates

Note: All this is for the short run.

Equilibrium with open economy

We need to clear

1. the goods market: IS
2. the money market: LM
3. the foreign exchange market

Four cases:

1. exchange rate: fixed or floating
2. capital mobility: perfect or none
   determines FX market clearing conditions

Open Economy IS Curve

We return to the short-run model where output is determined by aggregate demand

Start from the definition of aggregate demand in dollar terms

$$PZ = P(C+I+G+X) - EP^*IM \tag{1}$$

P: domestic price level (dollars)

P^*: foreign price level (pesos)

E: exchange rate (dollars/pesos)

EP^*: U.S. price of imports (dollars)

Open Economy IS Curve

Divide by P:

$$Z = C(\underset{+}{Y - T}) + I(\underset{+}{Y}, \underset{-}{i}) + G + X - \underbrace{\frac{E \times P^*}{P}}_{1/\varepsilon} IM \qquad (2)$$

r: real interest rate.

$\varepsilon = \frac{P}{EP^*}$ is the relative price of foreign goods

- the **real exchange rate**

Nominal Exchange Rate

Definition

The nominal exchange rate E is the price of one currency in terms of another

It comes in 2 "directions":

1. $E_{\$/¥}$: the price of yen: 1/116 \$/¥
2. $E_{¥/\$}$: the price of \$: 116 ¥/\$

$E_{¥/\$}$ rises - dollar **appreciates** (pay more yen for each dollar)

In the model: E **is in** $\$/¥$.

Therefore: $E\uparrow$ means that the dollar **depreciates**.

Real Exchange Rate

Definition

The real exchange rate answers the question: how much do the same goods cost in the U.S. relative to Japan?

- Form a "basket" of goods.
- Compute its cost in the U.S. (\$$P$) and Japan (¥$P^*$).
- Convert into dollars using the nominal exchange rate: the basket costs $E_{\$/¥}P^*$ in Japan.
- The ratio of dollar costs is the real exchange rate:

$$\varepsilon = \frac{P}{E_{\$/¥}P^*} = \frac{\text{cost in USA (\$)}}{\text{cost in Japan (\$)}} \tag{3}$$

Note: sometimes the RER is defined the other way around: $E_{\$/¥}P^*/P$.

Real exchange rate

The RER has no units:

$$[\varepsilon] = \frac{\$/good}{\$/¥ \times ¥/good} \tag{4}$$

If $\varepsilon = 1.5$ this means: in the U.S. goods cost 50% more than in Japan.

$\varepsilon \uparrow$ means: foreign goods get cheaper

When the dollar appreciates, $\varepsilon \uparrow$

A point to remember

In this class: dollar appreciation means $E \downarrow$ and $\varepsilon \uparrow$.

Determinants of Imports

Income effect: $Y \uparrow \Longrightarrow IM \uparrow$

- richer countries import more

Substitution effect: $\varepsilon = \frac{P}{EP^*} \uparrow \Longrightarrow IM \uparrow$

- dollar appreciates (in real terms) $\Longrightarrow$ imports rise
- but note that the dollar value of imports, IM/ε, may $\uparrow$ or $\downarrow$

Determinants of Exports

Income effect: $Y^* \uparrow \Longrightarrow X \uparrow$

Substitution effect: $\varepsilon \uparrow \Longrightarrow X \downarrow$

- domestic goods are more expensive
- the dollar value of exports falls unambiguously

Net Exports

The contribution of international trade to demand:

$$NX(\underset{-}{Y}, \underset{+}{Y^*}, \underset{?}{\varepsilon}) = X(\underset{+}{Y^*}, \underset{-}{\varepsilon}) - IM(\underset{+}{Y}, \underset{+}{\varepsilon})/\varepsilon \quad (5)$$

$Y \uparrow \implies$ trade balance $\downarrow$

- richer countries import more

$\varepsilon \uparrow \implies$ trade balance ambiguous

- so we use evidence to sign this effect (below).

Currency Depreciation

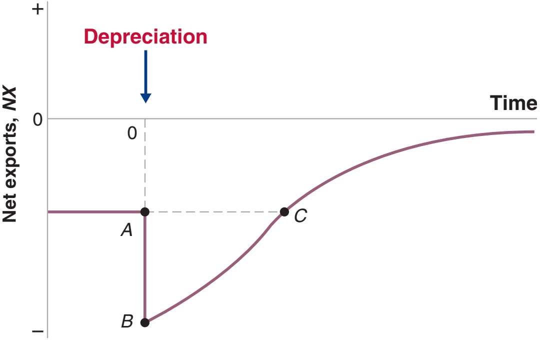
How a depreciation affects NX is theoretically ambiguous.

- Substitution effect:
  - dollar depreciates
  - foreign good become more expensive
  - $IM \downarrow$ and $X \uparrow$
- Value effect:
  - the dollar value of a given IM quantity rises

We will assume that a depreciation improves the trade balance:

$$\varepsilon \downarrow \Longrightarrow X - IM/\varepsilon \uparrow \tag{6}$$

J-Curve



- After depreciation: trade balance typically deteriorates initially
- Quantities take time to adjust
- In the short run the rise in import prices dominates

IS Curve

Assume that output is determined by demand: $Y = Z$

$$Y = C(\underset{+}{Y - T}) + I(\underset{+}{Y}, \underset{-}{i}) + G + \underbrace{X(Y^*, \varepsilon) - IM(Y, \varepsilon)/\varepsilon}_{NX(Y, Y^*, \varepsilon)} \qquad (7)$$

IS Curve

$$Y = C(Y - T) + I(Y, i) + G + NX(Y, Y^*, \varepsilon) \tag{8}$$

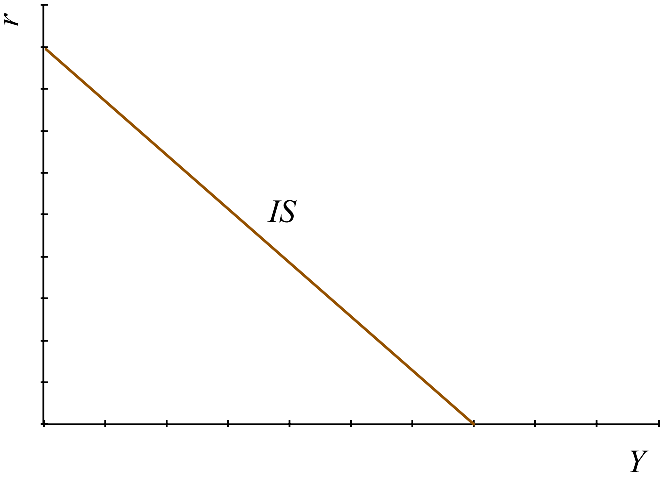
Slope is negative: $r \uparrow \implies Y \downarrow$

- same reason as in closed economy (investment falls)
- this holds ε fixed (won't be true in equilibrium)

Shifters are

- autonomous demands: C_0, I_0, G, Y^* (positive)
- taxes T (negative)
- real exchange rate ε (assumed positive)

IS Curve



This looks just like a closed economy IS curve
(but with a new shifter: ε)

Foreign exchange market clearing

Exchange rates in the short run

In the short run, the exchange rate is mainly an asset price.

Exchange rates play a dual role:

1. asset price:
   foreign vs domestic bonds, stocks, etc.
   massive trad volume **$2,400 trillion** per year (BIS, 2019)
2. goods price:
   exports vs imports
   much smaller trade volume

Short-run FX movements are mainly due to capital flows (asset trades)

What Determines Capital Flows?

Exchange rates move in response to international capital flows.

Capital flows respond to **risk adjusted returns** of investing at home vs abroad.

Factors that cause capital to flow into the U.S.:

1. high U.S. interest rate;
2. expected appreciation of the dollar;
3. increasing risk of investing abroad: political instability, external debt, ...

Uncovered Interest Parity (UIP)

A popular theory of exchange rate movements: UIP

Definition

Uncovered interest parity holds, if the dollar returns of investing at home and abroad the same

$$1 + i_{\$} = (1 + i_{¥}) \frac{E(t+1)}{E(t)} \tag{9}$$

or (approximately)

$$i_{\$} = i_{¥} + x \tag{10}$$

where:

- E is the exchange rate in $\$/¥$ ($E \uparrow$ means the $¥$ appreciates)
- $x = E(t+1)/E(t) - 1$ is the $¥$ rate of appreciation.

UIP Intuition

Suppose that

- two currencies pay the same interest: $i_{\$} = i_{¥}$
- investors expect the ¥ to appreciate by 5 pct over the next year.

Expected dollar return of

- investing at home: $i_{\$}$
- investing abroad: $i_{¥} + 5\%$

Investors move funds out of \$ into ¥. Then

- either interest rates adjust
- or the ¥ appreciates

until $i_{\$} = i_{¥} + x$.

Implications

If we see that a currency pays higher interest, investors expect it to depreciate in the future.

Intuition...

Example

Dollar: $i_{\$} = 0.05$
¥: $i_{¥} = 0.02$
Expectation: ¥ will appreciate by 3%

Risk Premiums

If currencies differ in risk, UIP subtracts a risk premium from the foreign currency return.

$$1 + i_{\$} = (1 + i_{¥} - RP_{¥}) \frac{E(t+1)}{E(t)} \tag{11}$$

or (approximately)

$$i_{\$} = i_{¥} - RP_{¥} + x \tag{12}$$

Higher risk premium $\implies$ higher interest rate $i_{¥}$.

Risk Premiums

The same from the foreign perspective

$$i_{¥} = i_{\$} - RP_{\$} - x \tag{13}$$

Therefore:

$$RP_{\$} = -RP_{¥} \tag{14}$$

.

The **risk premium must be negative** for one country.

How is this possible?

Digression: What is Risk?

Is risk just **payoff volatility**?

- Then all risk premiums would be positive (≥ 0)
- Counter-example:

Insight: some types of payoff fluctuations are good.

Which ones are bad (risk)?

Digression: What is Risk?

Example

Your income fluctuates.
When do you want to receive payments?

Compare two assets:

- Asset A pays you \$10,000 when you are poor.
- Asset B pays you \$10,000 when you are rich.

Both assets have the same payoff variance.

But A is clearly better than B (insurance).

Digression: What is Risk?

Example

There are two stocks:
A's value rises by 10% when it rains; otherwise it falls by 10%
B's value falls by 10% when it rains; otherwise it rises by 10%
Which asset is riskier?

Digression: What is Risk?

Insight

Risky assets pay high returns when you are already rich (stocks).
(Better than) Safe assets pay high returns when you are poor (insurance).
Risk is correlation of returns with your other sources of income.

When might foreign currencies have negative risk?

- Hint: think inflation risk.

How shocks affect the exchange rate

Solve the UIP condition

$$1 + i_{\$} = (1 + i_{¥} - RP_{¥}) \frac{E(t+1)}{E(t)} \tag{15}$$

for today's spot rate:

$$E(t) = E(t+1) \frac{1 + i_{¥} - RP_{¥}}{1 + i_{\$}} \tag{16}$$

The foreign currency appreciates when:

1. it becomes less risky
   $RP_{¥} \downarrow \implies E(t) \uparrow$
2. the foreign interest rate rises:
   $i_{¥} \uparrow \Longrightarrow E(t) \uparrow$.
3. The ¥ is expected to be more valuable in the future:
   $E(t+1) \uparrow \Longrightarrow E(t) \uparrow$

How shocks affect the exchange rate

Intuition: Good news such as lower risk or a higher interest rate make the ¥ attractive to investors. Its value rises.

Example

Start from $i_{\$} = i_{¥}$.
Investors view the ¥ as riskier: $RP \uparrow$
Violation of UIP: $i_{\$} > i_{¥} - RP$.
Traders sell ¥s until UIP is restored.
That requires $i_{\$} = i_{¥} - RP + x$.
To compensate for the risk, investors need to expect ¥ appreciation.

Is the ¥ strong when the interest rate is high?

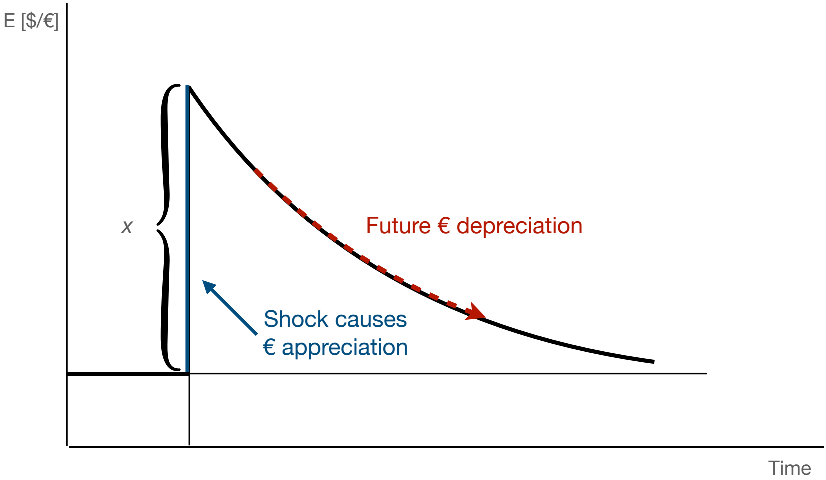
$$E(t) = E(t+1)\,\frac{1+i_{¥}-RP_{¥}}{1+i_{\$}} \tag{17}$$

Example

Today: $i_{\$} = i_{¥} = 10$ pct and $E(t) = 1$ [\$/¥]
No risk premium.
UIP: Investors must expect E to remain constant
Shock: ¥ interest rate rises to 15%
Key assumption: No change in $E(t+1)$!

Result:

Is the ¥ strong when the interest rate is high?



x is the expected depreciation of the ¥

Is the ¥ strong when the interest rate is high?

Key point

A rise in the ¥ interest rate leads to ¥ **appreciation**.
A high ¥ interest rates means that investors expect a ¥ **depreciation** in the future.

Expectations Matter

Fact

UIP determines $E(t)$ only relative to the future $E(t+1)$.

Changes in expectations about $E(t+1)$ are reflected immediately in the spot rate.

Possibility of self-fulfilling prophecies

- Without an anchor to pin down the long-run exchange rate, any E can be an equilibrium
- Mean-reversion to PPP (purchasing power parity) provides an anchor, but it is weak.
- This is generally true for asset prices.
- This is one reason why asset prices are so volatile.

Summary

We now have the pieces required to figure out equilibrium in the open economy:

1. good market clearing: IS

$$Y = C(\underset{+}{Y - T}) + I(\underset{+}{Y}, \underset{-}{i}) + G + X(Y^*, \varepsilon) - IM(Y, \varepsilon)/\varepsilon \qquad (18)$$

2. money / bond market clearing: LM

$$M/P = YL(i) \qquad (19)$$

3. FX market clearing
   3.1 perfect / high capital mobility: UIP

$$E_{\$/¥} = \frac{1+i^*}{1+i} E^e \qquad (20)$$

   3.2 no capital mobility:

$$NX = X - IM = 0 \qquad (21)$$

Some Comments

1. **LM** is unchanged: we assume that only locals hold currency
2. Since we take prices as given, we can use the nominal interest rate i instead of the real one (r)
3. We assume that a depreciation improves the trade balance
4. We rewrote UIP:

$$1+i=(1+i^{*})E^{e}/E \tag{22}$$

Reading

Blanchard / Johnson, Macroeconomics, 6th ed., ch. 18-20.

Explanations of UIP:

- Investopedia
- The Balance