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:

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

r: real interest rate.

$\varepsilon = P/EP^*$ 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:

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

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, $\varepsilon \uparrow$

Note:

- some people denote the RER the other way around: $E_{\$/¥} P^* / P$.
- 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 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:

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

$Y \uparrow \Longrightarrow$ trade balance $\downarrow$

- richer countries import more

$\varepsilon \uparrow \Longrightarrow$ trade balance ambiguous

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

IS Curve

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

$$Y = C(\underset{+}{Y - T}) + I(\underset{+}{Y}, \underset{-}{r}) + G + \underbrace{X(Y^*, \varepsilon) - IM(Y, \varepsilon)/\varepsilon}_{NX(Y, Y^*, \varepsilon)} \qquad (6)$$

Linear example:

$$\begin{aligned} Y &= \{C_0 + c_1(Y - T)\} + \{I_0 + i_1 Y - i_2 r\} + G \\ &\quad + \{x_1 Y^* - x_2 \varepsilon\} - \frac{im_1 Y + im_2 \varepsilon}{\varepsilon} \\ &= \frac{[C_0 - c_1 T + I_0 + G + x_1 Y^* - im_2] - x_2 \varepsilon - i_2 r}{1 - c_1 - i_1 + im_1/\varepsilon} \end{aligned}$$

IS Curve

$$Y = C(Y - T) + I(Y, r) + G + NX(Y, Y^*, \varepsilon) \tag{7}$$

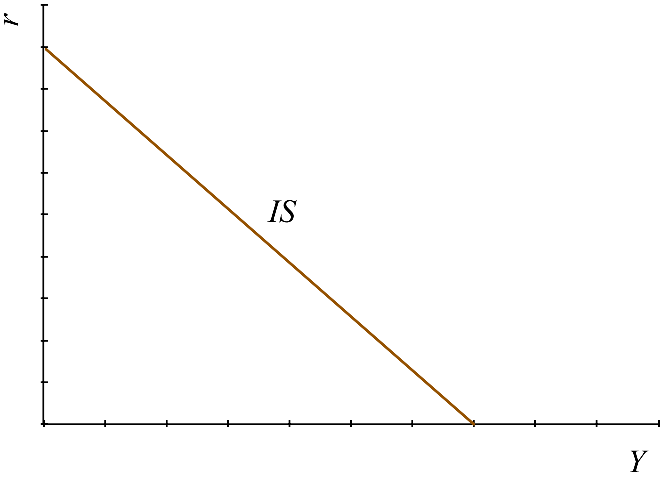
Slope is negative: $r \uparrow \implies Y \downarrow$

- 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 (sign ambiguous)

IS Curve



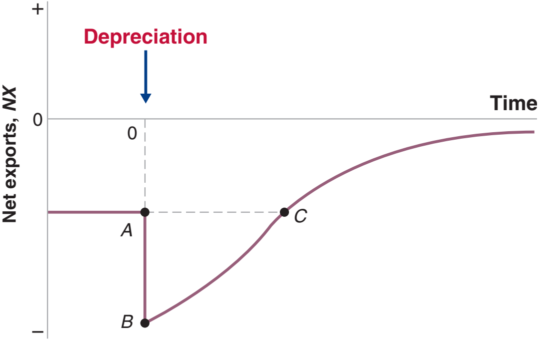
This looks just like a closed economy IS curve
(but with a new shifter: ε)

Currency Depreciation

- Whether a depreciation increases or decreases demand is 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 increases demand (and improves the trade balance):

$$\varepsilon \downarrow \Longrightarrow X - IM/\varepsilon \uparrow \tag{8}$$

J-Curve



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

Foreign exchange market clearing

Exchange rates in the short run

Exchange rates play a dual role:

- asset price: foreign vs domestic bonds, stocks, etc.
- goods price: exports vs imports

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

Global FX trading volume: **$2,400 trillion** per year (Source: BIS, 2019)

- about 17 times larger than global GDP

Trade in goods is so small that is plays little role (in the short run).

Exchange rates in the short run

Asset prices (in liquid markets) tend to fluctuate a lot.

- The reasons for the fluctuations are not well understood.
- Modern asset pricing theory predicts that prices should be much smoother than the data.

Therefore:

- *We don't know how short-run exchange rates are determined*.
- Much of the fluctuations are probably random noise.

What Determines Capital Flows?

We can get an idea about what moves exchange rates, if we understand what moves capital.

Capital flows into the U.S., if the risk adjusted rate of return of investing in dollars is higher than 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)

UIP is one theory of short-run exchange rate determination.

It does not hold all that well, but it has the right idea...

Definition

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

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

or (approximately)

$$i_{\$} = i_{Euro} + x \tag{10}$$

where:

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

Implications

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

Intuition...

Example

Dollar: $i_\$ = 0.05$
Euro: $i_€ = 0.02$
Expectation: € will appreciate by 3%

Risk Premiums

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

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

or (approximately)

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

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

Risk Premiums

The same from the European perspective

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

Therefore: $RP_{\$} = -RP_{Euro}$.

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?

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.

Examples where foreign currencies have negative risk?

How shocks affect the exchange rate

Solve the UIP condition

$$1 + i_{\$} = (1 + i_{Euro} - RP_{Euro})\,\frac{E(t+1)}{E(t)} \tag{14}$$

for today's spot rate:

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

The exchange rate responds to 3 types of shocks:

1. The Euro becomes less risky: $RP_{Euro} \downarrow$. Then $E(t) \uparrow$ (Euro appreciates)
2. The Euro interest rate rises or the dollar interest rate falls: $i_{Euro} \uparrow \Longrightarrow E(t) \uparrow$.
3. The Euro 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 Euro attractive to investors. Its value rises.

Example

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

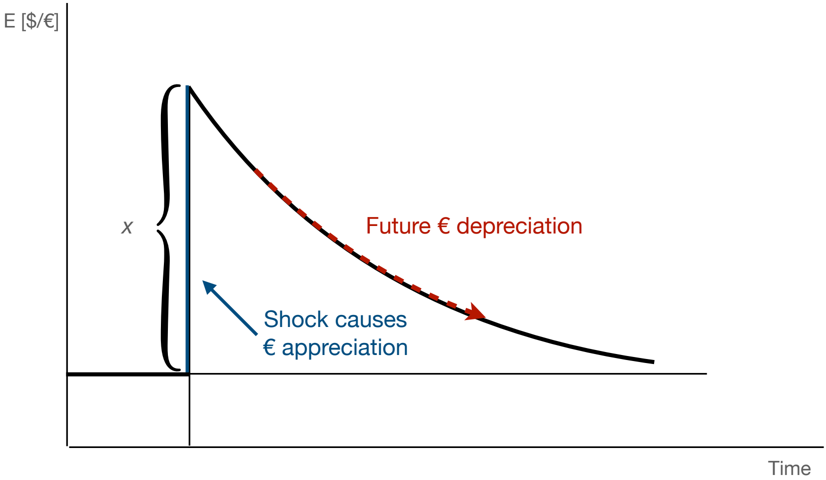
Is the Euro strong when the interest rate is high?

Example

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

Result:

Is the Euro strong when the interest rate is high?



x is the expected depreciation of the Euro

Is the Euro strong when the interest rate is high?

Key point

A rise in the Euro interest rate leads to Euro **appreciation**.
A high Euro interest rates means that investors expect a Euro **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
$$Y = C(\underset{+}{Y - T}) + I(\underset{+}{Y}, \underset{-}{r}) + G + X(Y^*, \varepsilon) - IM(Y, \varepsilon)/\varepsilon \tag{16}$$
2. money / bond market clearing: LM
$$M/P = YL(i) \tag{17}$$
3. FX market clearing
    1. perfect / high capital mobility: UIP
    $$E = \frac{1+i^*}{1+i} E^e \tag{18}$$
    2. no capital mobility:
    $$NX = X - IM = 0 \tag{19}$$

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:

$$1 + i = (1 + i^*)E/E^e \tag{20}$$

Reading

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

Explanations of UIP:

- Investopedia
- The Balance