Open Economy Model

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Objectives

In this section you will learn

1. how to extend the AS/AD 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

Equilibrium with open economy

We need to clear

1. the goods market: IS + AS
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

What differs

Opening up the economy changes:

1. Foreign demand contributes to AD.
   The IS curve changes.
2. Foreign exchange market clearing.
   We have one more market and one more price (exchange rate).

IS Curve

Open Economy IS Curve

Start from the definition of aggregate demand in dollar terms

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

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:

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

$\varepsilon = \frac{P}{EP^*}$ 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 Exports

Export quantity = (real) export value = X

- because exports are in units of the domestic good
- their relative price is 1

Export quantity depends on income Y and relative prices ε.

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

- richer countries import more

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

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

Determinants of Imports

Import quantities IM depend on

- income Y and
- relative prices ε

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

We write $IM(\underset{+}{Y}, \underset{+}{\varepsilon})$

Dollar value of imports

The dollar value of imports is $E \times P^* \times IM$.

In real terms (units of domestic goods):

$$\frac{E \times P^* \times IM}{P} = \frac{IM}{\varepsilon} \tag{5}$$

Real dollar appreciation ($\varepsilon \uparrow$)

- raises the quantity imported
- reduces (real) import prices
- the change in import values is **ambiguous**

Net Exports

The contribution of international trade to demand:

$$NX(\underset{-}{Y}, \underset{+}{Y^*}, \underset{?}{\varepsilon}) = X(\underset{+}{Y^*}, \underset{-}{\varepsilon}) - IM(\underset{+}{Y}, \underset{+}{\varepsilon})/\varepsilon \tag{6}$$

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

- richer countries import more

$\varepsilon \uparrow \Longrightarrow$ trade balance ambiguous

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

Currency Depreciation

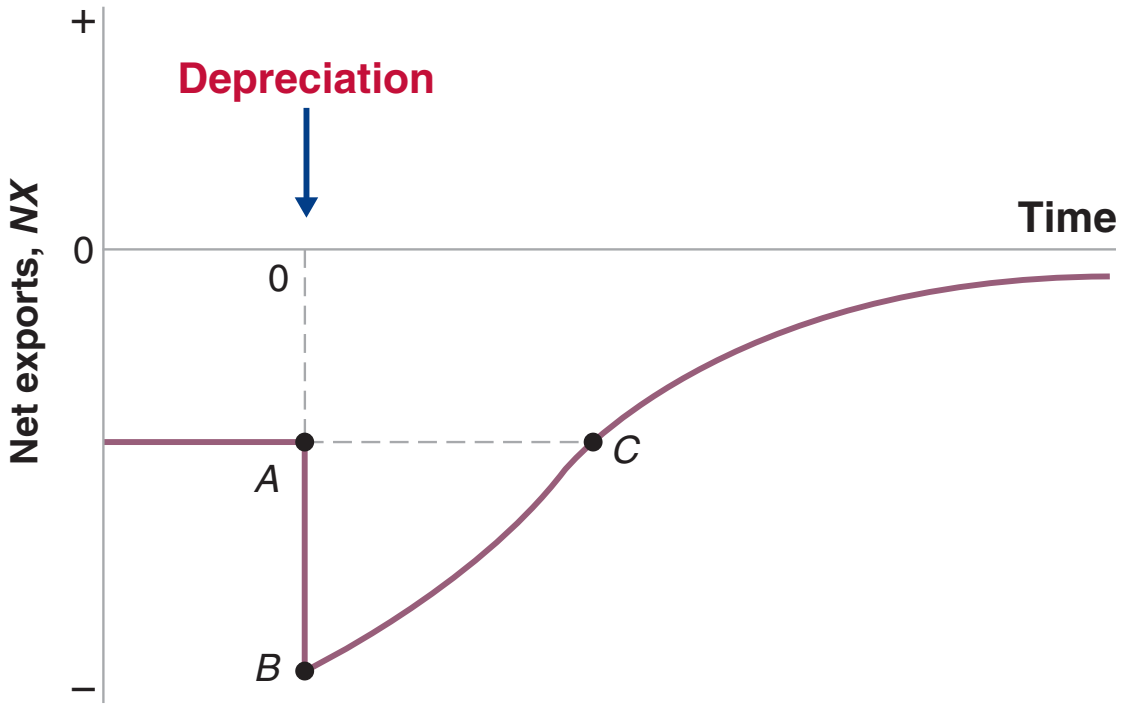
How a depreciation affects NX is theoretically ambiguous.

- 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:

$$\varepsilon \downarrow \Longrightarrow X - IM/\varepsilon \uparrow \tag{7}$$

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

In equilibrium, output is determined by demand: $Y = Z$

$$Y = C(\underset{+}{Y - T}) + I(\underset{+}{Y}, \underset{-}{i}) + G + \underbrace{X(Y^*, \varepsilon) - IM(Y, \varepsilon)/\varepsilon}_{NX(Y, Y^*, \varepsilon)} \tag{8}$$

IS Curve

$$Y = C(Y-T) + I(Y,i) + G + NX(Y,Y^*,\varepsilon) \tag{9}$$

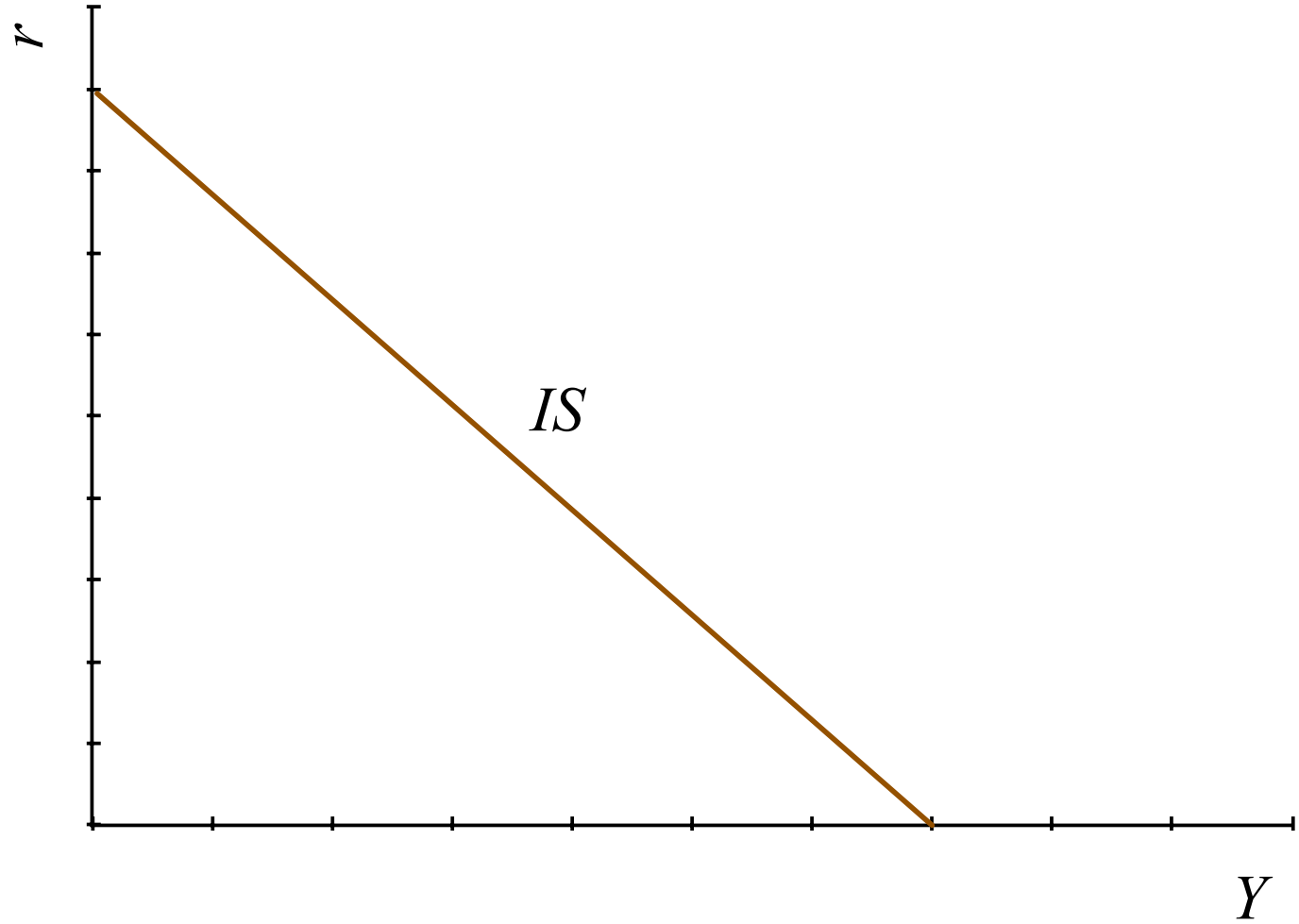
Slope is negative: $i \uparrow \Longrightarrow Y \downarrow$

- 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 (dollar depreciation improves NX)

IS Curve



This looks just like a closed economy IS curve

(but with a new shifter: ε)

Foreign exchange market clearing

Exchange Rate Interventions

Almost all central banks intervene in FX markets

The mechanics:

- buy dollars and sell Euros (or vice versa)

Key point

Each intervention changes the money supply.

This produces a conflict: the CB has one instrument (M) but 3 targets

- stable inflation
- stable output
- stable exchange rate

Exchange Rate Regimes

- Two extremes:
  - **floating**: the CB does not buy or sell FX
  - **fixed**: the CB stands ready to buy/sell any amount of FX at a fixed E
- Reality is somewhere in between
- We first study fixed exchange rates (easier).

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).

Pegging and Monetary Control

How can the exchange rate be fixed when capital is mobile?

With a fixed exchange rate (that is credible), domestic bonds and foreign bonds are perfect substitutes.

They have to pay the same interest rate:

$$i = i^* \tag{10}$$

The CB has no control over the interest rate

What happens if the Fed tries to change the interest rate?

- short answer: capital flows overwhelm the Fed
- long answer: below

Monetary control

Money market clearing

$$M/P = YL(i^*) \tag{11}$$

The CB has no control over the money supply either.

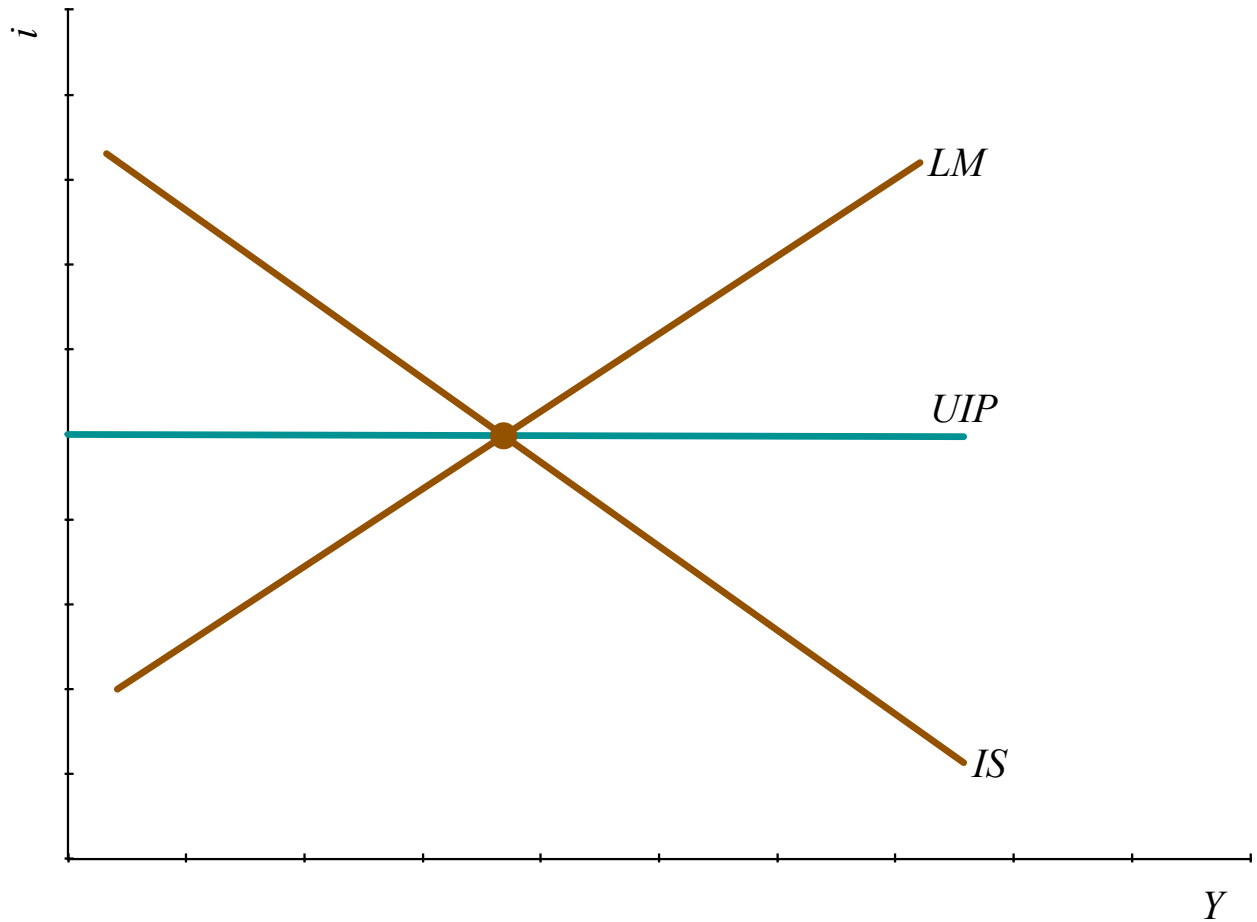
Why?

- short answer: the Fed needs to set M/P to keep $i = i^*$
  - otherwise: capital flows overwhelm the Fed
- long answer: below

Open Market Operations

What happens if the CB tries to increase the money supply?

- Open market operation: buy bonds in exchange for money.



Open Market Operations

The CB buys bonds with high powered money

- LM shifts right: $M \uparrow, i \downarrow$
- downward pressure on the dollar

In the FX market: CB must buy dollars to keep the peg

- LM shifts left: $M \downarrow \Longrightarrow i = i^*$
- FX reserves $\downarrow$

Net result:

- The CB has effectively paid for the bonds with FX reserves.
- M stays unchanged (as required by UIP)

Reality Check

- We have assumed perfect capital mobility (UIP)
- In reality, Central Banks have some control over the domestic interest rate
- Outcomes are somewhere in between closed economy and perfect capital mobility.

Summary

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

1. good market demand: IS

$$Y = C(\underset{+}{Y - T}) + I(\underset{+}{Y}, \underset{-}{i}) + G + X(Y^*, \varepsilon) - IM(Y, \varepsilon)/\varepsilon \qquad (12)$$

2. money / bond market clearing: LM

$$M/P = YL(i) \qquad (13)$$

3. AS (same as closed economy)
4. FX market clearing

$$i = i^* \qquad (14)$$

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

Reading

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

Explanations of UIP:

- Investopedia
- The Balance