

# 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 ✓
2. the money market: LM ✓
3. the labor market: AS ✓
4. 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 from closed economy

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).

## 2. IS Curve

# Open Economy IS Curve

Start from the definition of aggregate demand in dollar terms

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

$P$ : domestic price level (dollars)

$P^*$ : foreign price level (pesos)

$E$ : exchange rate (dollars/pesos)

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

$$Z = C + I + G + \underbrace{X - IM}_{NX}$$

# Open Economy IS Curve

Divide by  $P$ :

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

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

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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 ( $\yen P^*$ ).
- ▶ Convert into dollars using the nominal exchange rate: the basket costs  $E_{\$/\yen}P^*$  in Japan.  $\rightarrow$  
- ▶ The ratio of dollar costs is the real exchange rate:

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

Note: sometimes the RER is defined the other way around:

$$E_{\$/\yen}P^*/P.$$

## Real exchange rate

The RER has no units:

$$[\epsilon] = \frac{\$/good}{\$/\text{¥} \times \text{¥}/good} \quad (4)$$

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

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

When the dollar appreciates,  $\epsilon \uparrow$

A point to remember

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

## Determinants of Exports

$$P_X - \epsilon P^* \cdot \pi$$

Export quantity = (real) export value =  $X$

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

Export quantity depends on foreign income  $Y^*$  and relative prices  $\epsilon$ .

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

- ▶ richer countries import more

Substitution effect:  $\epsilon \uparrow \implies X \downarrow$

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

$$X(Y^*, \epsilon)$$

# Determinants of Imports

Import quantities  $IM$  depend on

- ▶ income  $Y$  and
- ▶ relative prices  $\epsilon$

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

- ▶ richer countries import more

Substitution effect:  $\epsilon = \frac{P}{EP^*} \uparrow \implies IM \uparrow$

- ▶ dollar appreciates (in real terms)  $\implies$  imports rise

We write  $IM(Y, \epsilon)$

$IM(Y, \epsilon)$   
+ +

$C(Y, \tau, i, P)$

$Y - T \rightarrow C$

$\varepsilon \rightarrow IM$

$\searrow C - IM$

= domestic goods  
consumption

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NOT CORRECT!

$P \downarrow$   $Y$  fixed

Purchasing power  $\uparrow$   
 $\Rightarrow C \uparrow$

## Dollar value of imports

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

In real terms (units of domestic goods):

$$\frac{E \times P^* \times IM}{P} = \frac{IM}{\epsilon} \quad (5)$$

Real dollar appreciation ( $\epsilon \uparrow$ )

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

# Net Exports

The contribution of international trade to demand:

$$NX(Y, Y^*, \varepsilon) = X(Y^*, \varepsilon) - IM(Y, \varepsilon) / \varepsilon \quad (6)$$

$Y \uparrow \implies$  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:

$$\varepsilon \downarrow \implies X - IM/\varepsilon \uparrow \quad (7)$$



## IS Curve

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

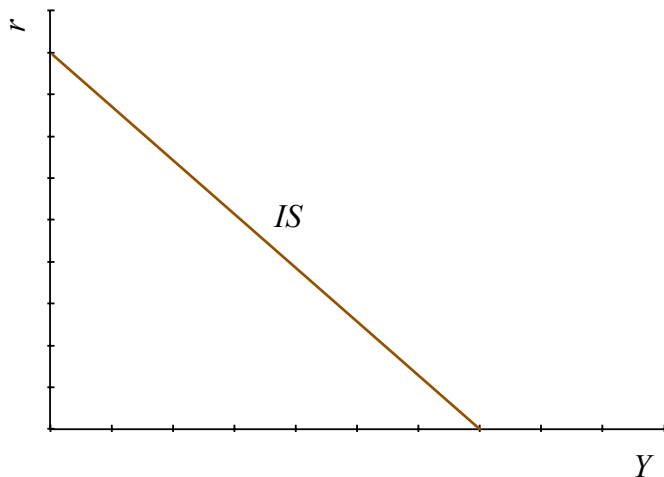
**Slope** is negative:  $i \uparrow \implies Y \downarrow$

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

**Shifters** are

- ▶ autonomous demands:  $C_0, I_0, G, Y^*$  (positive)
- ▶ taxes  $T$  (negative)
- ▶ real exchange rate  $\varepsilon$  (dollar depreciation improves  $NX$ )

## IS Curve



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

### 3. 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).

No capital flows  $\Rightarrow$

Balanced trade

$$NX = 0$$

$$I = S^P + S^G - \underbrace{NX}_{S^{\text{Foreign}}}$$

## Exchange rates in the short run

Exchange rates play a dual role:

1. **asset price:**

foreign vs domestic bonds, stocks, etc.

massive trade 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).

## 4. Fixed exchange rates

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

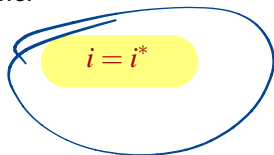
- ▶ We still need to clear the FX market.

Financial investors need to be indifferent between holding foreign and domestic bonds.

- ▶ Otherwise capital flows put pressure on the exchange rate.

Investors compare domestic and foreign rates of return.

They have to be the same:


$$i = i^*$$

(9)



# Monetary control

Money market clearing

$$M/P = YL(i^*) \quad (10)$$

The CB has adjust the money supply at all times to ensure  $i = i^*$ .

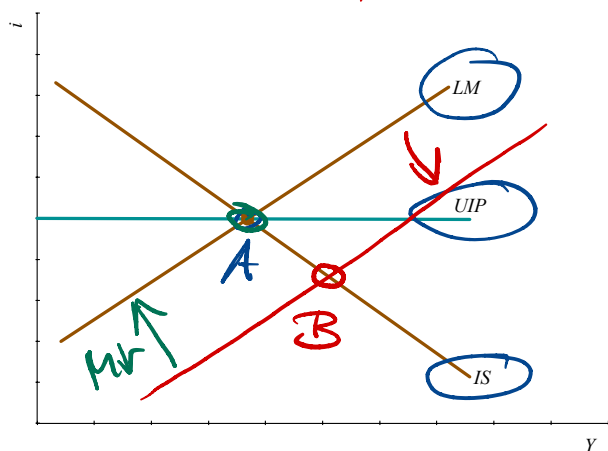
## Key result

With fixed exchange rates, the central bank loses control over the money supply and over interest rates.

# Open Market Operations

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

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



Fix P

B - closed  $\bar{i} < \bar{i}^*$

$M \uparrow$   
 $i = i^*$   
Cap. outflow  
 $E \uparrow$   
(FX appreciable)  
Sell FX  
Buy \$  
economy

# 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:  $M \downarrow \implies i = i^*$
- ▶ FX reserves  $\downarrow$

Net result:

- ▶ The CB has effectively paid for the bonds with FX reserves.
- ▶  $M$  stays unchanged (as required by  $i = i^*$ )

## 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. goods market demand: IS

$$Y = C(Y - T) + I(Y, i) + G + X(Y^*, \epsilon) - IM(Y, \epsilon)/\epsilon \quad (11)$$

2. LM (same as closed economy)

$$M/P = YL(i) \quad (12)$$

3. AS (same as closed economy)

4. FX market clearing

$$i = i^* \quad (13)$$

## Analyzing the Model

The model equations are the same for fixed and floating exchange rates.

- ▶ except for a detail in FX market clearing...

But the logic of the model varies.

1. Floating:

The exchange rate is endogenous (clears the FX market)

The Fed controls  $M$

2. Fixed:

The exchange rate is exogenous (fixed by the Fed)

$M$  is endogenous (needs to adjust to keep  $i = i^*$ )

# Reading

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

Explanations of UIP:

- ▶ Investopedia
- ▶ The Balance