Open economy

Harvard Economics 1011B
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Spring 2020

Outline

1. Overview
2. Exchange rates (see Mankiw chapter 6)
3. Exchange rates, interest rates, and capital flows
4. IS-MP
5. Application: tax policy and net exports

Outline

Open economy

- Economy produces total output Y_t each period.
- Closed economy: Y_t allocated among private consumption C_t, private investment I_t, and government consumption and investment G_t, $Y_t = C_t + I_t + G_t$.
- Open economy: output also sold to foreigners as exports X_t, but part of $C_t + I_t + G_t$ is purchased from abroad as imports M_t, $Y_t = C_t + I_t + G_t + X_t - M_t = C_t + I_t + G_t + NX_t$.
- Question 1: what determines NX_t?
- Question 2: how does NX_t affect analysis of fiscal and monetary policy?

CONCEPTS

1. Nominal exchange rate, real exchange rate, and law of one price.
2. Fixed versus floating exchange rates.
3. Interest parity and the trilemma.
4. Capital flows and net exports.
5. Exchange rate overshooting.
6. Open economy IS-MP.
7. Application.

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The nominal exchange rate

e = nominal exchange rate,
the relative price of
domestic currency
in terms of foreign currency

(*e.g.* yen per dollar)

A few exchange rates, as of 6/26/2014

country	*exchange rate*
Euro area	0.73 euro/$
Indonesia	12,101 rupiahs/$
Japan	101.7 yen/$
Mexico	13.0 pesos/$
Russia	33.69 rubles/$
South Africa	10.65 rand/$
U.K.	0.59 pounds/$

Getting the sign right

- The exchange rate is a relative price. Equally valid to quote domestic/foreign or foreign/domestic.
- Convention in much of economics is to quote domestic/foreign.
- Convention in Mankiw and this class is to quote foreign/domestic.
- Then we say that a rise in the exchange rate is an appreciation.
- To get the sign right, always ask whether an increase means one dollar can buy more foreign currency. If yes, then an increase is an appreciation of the dollar.

The real exchange rate

$\boldsymbol{\varepsilon}$ = real exchange rate,
the relative price of
domestic goods
in terms of foreign goods

(*e.g.* Japanese Big Macs per U.S. Big Mac)

the lowercase Greek letter epsilon

Understanding the units of ε

$$\varepsilon = \frac{e \times P}{P^*}$$

$$= \frac{(\text{Yen per \$}) \times (\text{\$ per unit U.S. goods})}{\text{Yen per unit Japanese goods}}$$

$$= \frac{\text{Yen per unit U.S. goods}}{\text{Yen per unit Japanese goods}}$$

$$= \begin{array}{c}\text{Units of Japanese goods}\\ \text{per unit of U.S. goods}\end{array}$$

~ McZample ~

- one good: Big Mac
- price in Japan:
  P* = 200 Yen
- price in USA:
  P = $2.50
- nominal exchange rate
  e = 120 Yen/$

$$\varepsilon = \frac{e \times P}{P^*}$$

$$= \frac{120 \times \$2.50}{200 \text{ Yen}} = 1.5$$

To buy a U.S. Big Mac, someone from Japan would have to pay an amount that could buy 1.5 Japanese Big Macs.

ε in the real world & our model

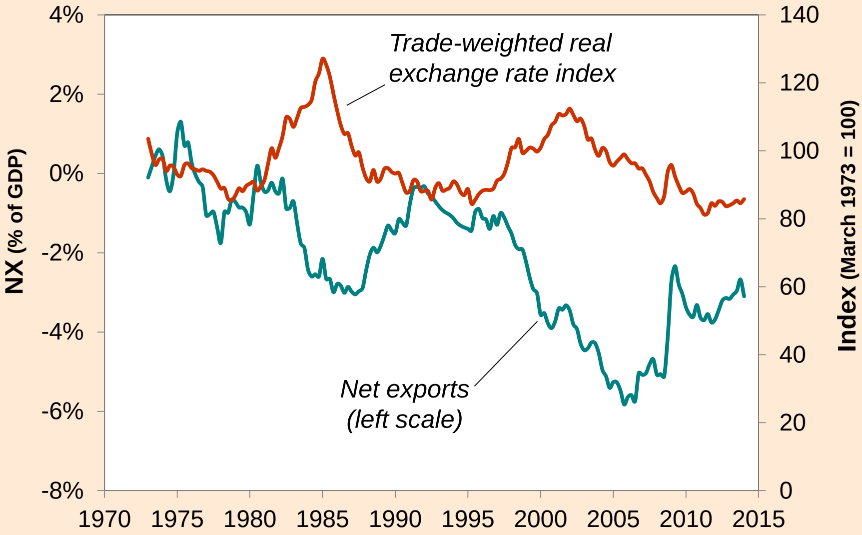
- In the real world:
  We can think of ε as the relative price of a basket of domestic goods in terms of a basket of foreign goods
- In our macro model:
  There's just one good, "output."
  So ε is the relative price of one country's output in terms of the other country's output

How *NX* depends on ε

If ε rises:

- U.S. goods become more expensive relative to foreign goods
- exports fall, imports rise
- net exports fall

U.S. net exports and the real exchange rate, 1973–2014



Real exchange rate versus law of one price

- LOP: converted into common currency and up to shipping costs, a bushel of wheat sells for the same amount everywhere.
  - Otherwise there is an arbitrage opportunity.
- The real exchange rate is the relative price of basket of goods in two countries expressed in common units. Should it always be 1?
- No, because some goods are not tradable.
  - Can't buy haircuts in Mexico and sell them in the U.S.

Real exchange rate in the long run

- The real exchange rate moves around substantially in the short and medium run but exhibits no trend in the long run.
- This is a stylized feature of many advanced economies.
- Why? Suppose relative price of non-traded goods in U.S. rises. Then capital and labor move from traded to non-traded sector, which raises price of traded goods and lowers price of non-traded goods. As traded goods prices rise, people switch expenditure to foreign goods and foreign producers raise their prices.
- In the short run, if prices are sticky, then real exchange rate can depart from its long run level.

Exchange rate regimes

- The U.S. has a *floating* exchange rate. This means the value of the dollar fluctuates continously.
- Some countries have *fixed* exchange rates or belong to currency unions.
    - Example 1: The euro area consists of 19 countries which share a common currency.
    - Example 2: Under a gold standard, a country fixes the value of its currency relative to the price of gold.
    - Example 3: China operates a *managed float*. It allows the remnibi to fluctuate but only by a small amount each day.
- How does a country fix its currency? The central bank announces it will buy or sell at the fixed rate. It can buy only if it has *reserves* to sell.

Float versus fixed

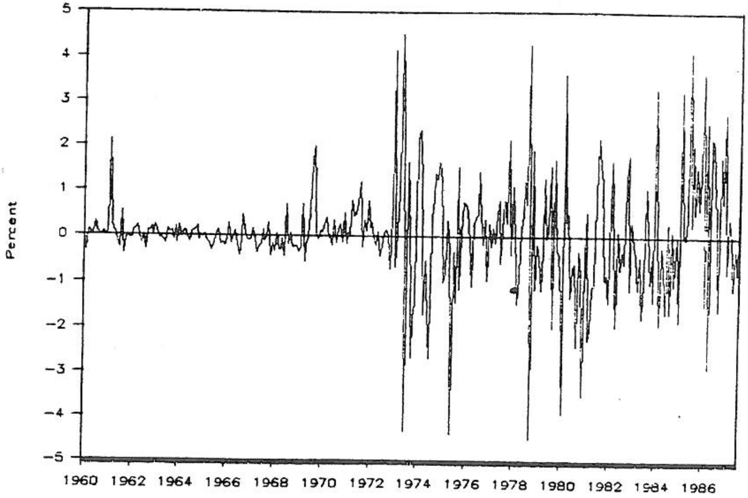


Figure 1.4
Monthly changes in real exchange rate between the United States and the Federal Republic of Germany, 1960–1986.

Outline

Interest parity

- You want to invest \$1 in period t to be able to consume in $t+1$.
- Option 1: invest in domestic bond and receive $\$1+i_{t,t+1}$ in $t+1$.
- Option 2: invest in German bond in period t. To invest in German bond, first convert \$1 into euros, then buy bond, then convert euros in $t+1$ back into dollars.
- Payoffs:

	Buy U.S. bond	Buy German bond
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$t+1$	Receive $\$1+i_{t,t+1}$	Receive €$e_t\left(1+i^*_{t,t+1}\right) \Rightarrow$ $\$\frac{1}{e_{t+1}}e_t\left(1+i^*_{t,t+1}\right)$

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- Both options translate \$1 in t into some amount of \$ in $t+1$. So you must be indifferent between them:

$$1+i_{t,t+1} = e_t(1+i^*_{t,t+1})\frac{1}{e_{t+1}}.$$

Interest parity

- Take logs, use $\ln(1+i) \approx i$ and $\ln \frac{e_t}{e_{t+1}} = -\ln \frac{e_t + \Delta_{t,t+1} e}{e_t} \approx -\frac{\Delta_{t,t+1} e}{e_t} = -\%\Delta_{t,t+1} e$:

$$i_{t,t+1} \approx i^*_{t,t+1} - \%\Delta_{t,t+1} e.$$

- Example: 2 year U.S. Treasury note offers annual interest rate of 2.33%. 2 year German bill offers annual interest rate of -0.57%. So expectation is dollar will depreciate by 2.8% per year.
- Intuition: when you invest in foreign bond, you get the foreign interest rate plus the change in the value of the dollar between when you buy the bond and when it matures.
- Note: we assume here either *perfect foresight* or indifference to exchange rate risk.

THE TRILEMMA

- Fixed exchange rate: $\%\Delta_{t,t+1}e = 0$.
- Perfect capital mobility: investor can arbitrage interest parity.
- Result: With fixed exchange rate and perfect capital mobility, $i_{t,t+1} = i^*_{t,t+1}$.
- Monetary trilemma: a country cannot simultaneously peg a fixed exchange rate, allow free capital mobility, and conduct independent monetary policy.
- In what follows we will assume the U.S. case: free capital mobility and independent monetary policy.
- We'll consider a fixed exchange rate when we discuss the euro.

$S - I = NX$

$$
\begin{aligned}
Y &= C + I + G + NX \\
\Rightarrow NX &= [(Y - T - C) + (T - G)] - I \\
&= S - I.
\end{aligned}
$$

- $Y - T - C$: Domestic private savings.
- $T - G$: Domestic government savings.
- $S = Y - C - G$: Total domestic savings.
- $S - I = CF$: Savings less investment = net capital outflows.
- Intuition: if U.S. buys more output from rest of world than it sells, it must borrow the difference $\Rightarrow$ $S - I < 0$.

$S - I = NX$ AND r AND ε

- $NX = NX(\varepsilon), NX'(\varepsilon) < 0$.
- $CF = CF(r), CF'(r) < 0$.
- If capital flows fall when the real interest rate rises, then net exports also fall, which means the real exchange rate must appreciate.
- How does this happen?

Exchange rate overshooting (Dornbusch, 1976)

- Suppose in some period t $i_{t,t+1} = i^*_{t,t+1}$, and then Fed lowers U.S. interest rate but foreign interest rate remains unchanged:

$$i_{t,t+1} \downarrow, i^*_{t,t+1} \text{ unchanged} \Rightarrow \%\Delta_{t,t+1} e \uparrow .$$

  Fed lowering interest rate means dollar is expected to appreciate.
- Fed lowering interest rate also generates domestic inflation (why?). Then $\pi_{t,t+1} > \pi^*_{t,t+1}$.
- In the long run, if real exchange rate is unchanged, then:

$$\varepsilon_t = \frac{e_t P_t}{P^*_t}, \; P \uparrow, P^* \text{ unchanged} \Longrightarrow e \downarrow .$$

- In the long run dollar has depreciated, but for UIP to hold dollar must be expected to appreciate. How does this happen? Dollar must depreciate immediately, and by more than the long run amount of depreciation.

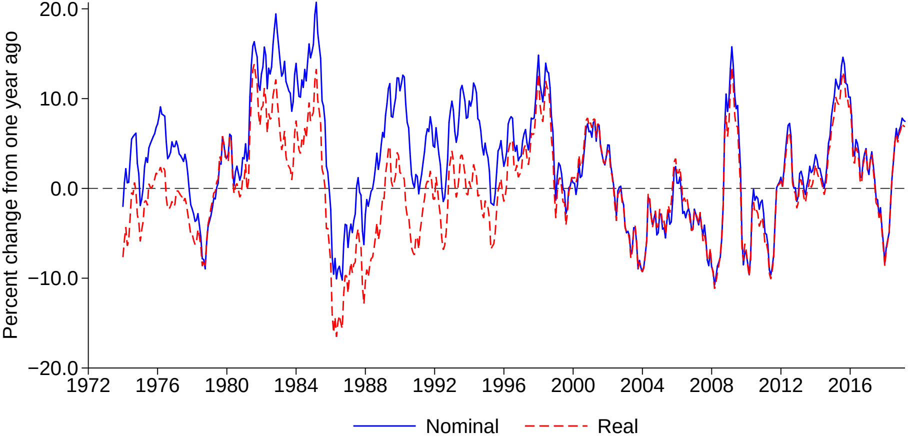
Exchange rate overshooting II

- Suppose dollar didn't depreciate immediately. Then U.S. investors would sell dollars and buy foreign currency to obtain higher interest rates abroad. Selling dollars pushes down value of dollar, until currency has depreciated enough to generate expected appreciation.
- With fixed prices or sluggish inflation, change in nominal exchange rate implies change in real exchange rate.
- Conclusion: decline in interest rate $\Rightarrow$ depreciation of exchange rate $\Rightarrow$ net exports rise.
- In math, by the chain rule:

$$\frac{\partial NX}{\partial r} = \frac{\partial NX}{\partial \varepsilon}\frac{\partial \varepsilon}{\partial r} = \underbrace{\frac{\partial NX}{\partial \varepsilon}}_{<0}\underbrace{\frac{\partial \varepsilon}{\partial e}}_{>0}\underbrace{\frac{\partial e}{\partial i}}_{>0}\underbrace{\frac{\partial i}{\partial r}}_{>0} < 0.$$

- Note: $\frac{\partial \varepsilon}{\partial e} > 0, \frac{\partial i}{\partial r} > 0$ are short run relationships which follow from sluggish price adjustment.
- For short we will write $NX(r), NX'(r) < 0$.

Trade-weighted dollar



- Nominal exchange rate and real exchange rate tightly connected.
- Especially true over past 20 years. Before nominal exchange rate appreciated more/depreciated less than real exchange rate. Why?

Outline

Open economy, goods market

- Total expenditure:

$$Y = C + I + G + NX. \tag{1}$$

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$$NX = N(r). \tag{4}$$

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  - $N'(r) < 0$.
- G: government purchases of output. Exogenous.
- T: government taxes. Exogenous.

Keynesian cross

- (2)+(3) + (4) + G:

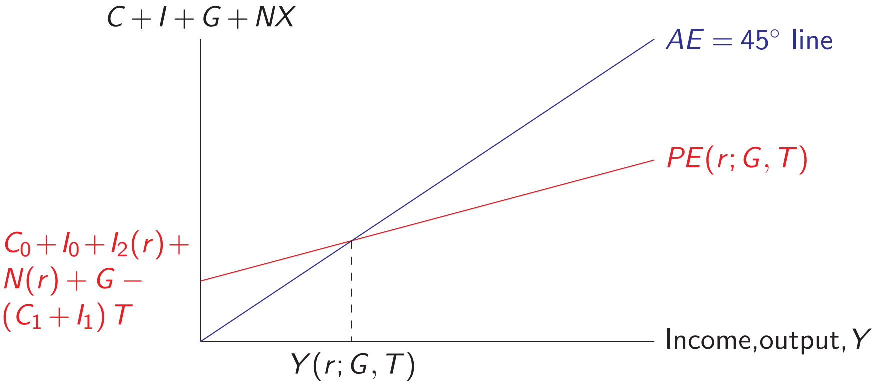
$$
\begin{aligned}
C+I+G+NX &= \underbrace{[C_0+C_1(Y-T)]}_{C}+\underbrace{[I_0+I_1(Y-T)+I_2(r)]}_{I}+\underbrace{[N(r)]}_{NX}+G \\
&= \underbrace{C_0+I_0+G-(C_1+I_1)T+I_2(r)+N(r)+(C_1+I_1)Y.}_{\text{Planned expenditure } (PE)}
\end{aligned}
$$

- Actual expenditure (AE):

$$C+I+G+NX=Y.$$

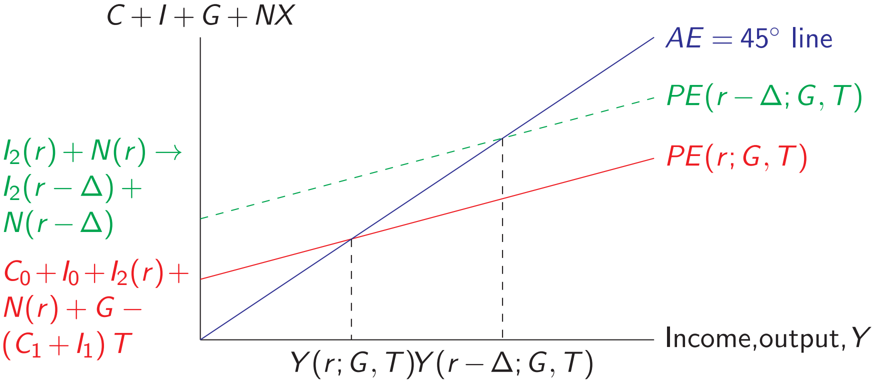
- Both equations must hold in an equilibrium.

Geometric equilibrium: Keynesian cross



- $PE = [C_0 + I_0 + I_2 r + N(r) + G - (C_1 + I_1)\,T] + (C_1 + I_1)\,Y$. Total expenditure as function of Y, at given level of r, G, T.
- Slope of PE : $C_1 + I_1 < 1$: marginal propensity to spend.
- $Y(r; G, T)$: *equilibrium* output given r, G, T.

CHANGES IN r



- $r \downarrow \Rightarrow I^{\uparrow}, NX \uparrow \Rightarrow Y^{\uparrow}$.
- Figure shows two possible equilibrium duples of Y, r.
- An infinite number of possible combinations of Y, r exist that would satisfy equilibrium.
- The *IS* curve is the set of points in Y, r space such that equilibrium obtains in the goods market.

IS curve algebraically

- 4 equations in 5 unknowns Y, C, I, NX, r:

$$
\begin{aligned}
Y &= C + I + G + NX, \\
C &= C_0 + C_1(Y - T), \\
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- Substitute and solve:

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\begin{aligned}
Y &= \underbrace{[C_0 + C_1(Y - T)]}_{C} + \underbrace{[I_0 + I_1(Y - T) + I_2(r)]}_{I} + G + N(r)\\
&= [C_0 + I_0 + I_2(r) + NX(r) + G - (C_1 + I_1)T] + (C_1 + I_1)Y,\\
\Longrightarrow Y &= \frac{C_0 + I_0 + G - (C_1 + I_1)T}{1 - C_1 - I_1} + \frac{1}{1 - C_1 - I_1}(I_2(r) + N(r)).
\end{aligned}
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IS CURVE ALGEBRAICALLY

- 4 equations in 5 unknowns Y, C, I, NX, r:

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\end{aligned}$$

- Still have downward sloping IS curve in (r, Y) space.

Monetary policy feedback rule (Taylor rule)

$$i_{t,t+1} = r^*_{t,t+1} + \pi^*_{t,t+1} + \phi_Y(Y_t - Y^*_t) + \phi_\pi(\pi_{t,t+1} - \pi^*_{t,t+1}).$$

- Y^*_t: Fed's target for output; $\pi^*_{t,t+1}$: Fed's target for inflation; $r^*_{t,t+1}$: real interest rate when $Y_t = Y^*_t$ and $\pi_{t,t+1} = \pi^*_{t,t+1}$.
- $\phi_Y > 0$: when output is below target, Fed lowers interest rates.
- $\phi_\pi > 0$: when inflation is above target, Fed raises interest rates.
- Assumption: ϕ_Y, ϕ_π large enough, and inflation sluggish enough, that Fed raises real interest rate. This is usually true.
- Simplifying assumption: Fed directly controls short term real interest rate:

$$r_{t,t+1} = r(Y_t; \pi_{t,t+1}), \quad r'(Y_t) > 0.$$

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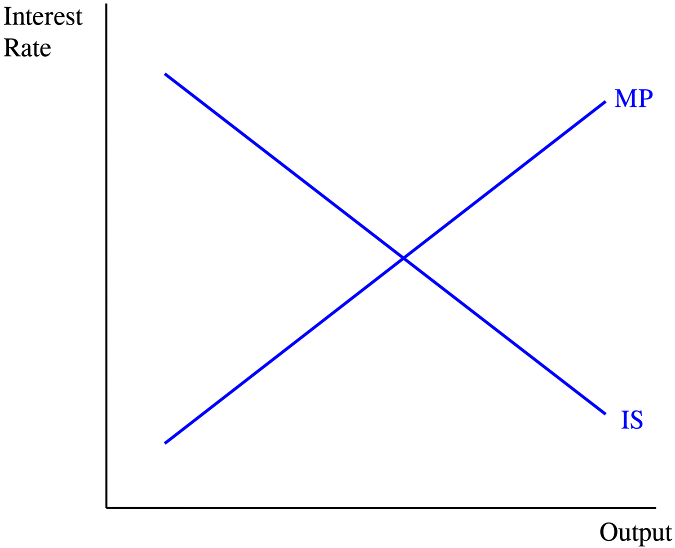
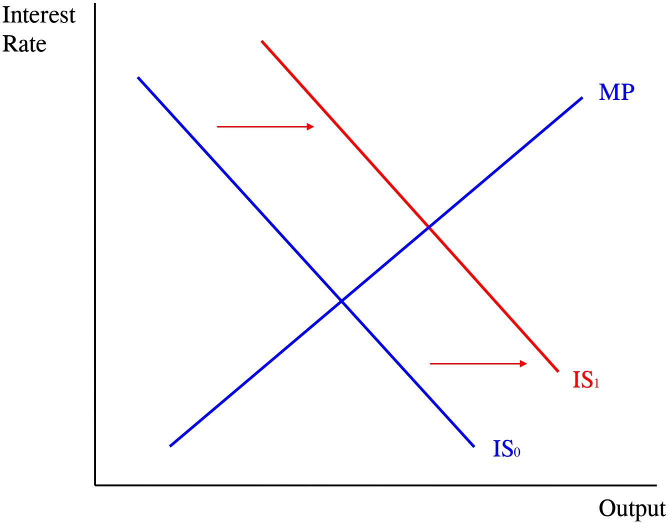
- Open economy: Fed policy affects exchange rate, but no reason to assume any change in the monetary policy rule.

IS-MP DIAGRAM, OPEN ECONOMY



Expansionary fiscal policy



- Output and interest rate both rise.

Expansionary fiscal policy, algebraic

- IS curve and MP curve give two equations in two unknowns r, Y:

$$Y = \frac{C_0 + I_0 + G - (C_1 + I_1)\,T}{1 - C_1 - I_1} + \frac{(I_2(r) + N(r))}{1 - C_1 - I_1}, \quad I_2'(r), N'(r) < 0,$$
$$r = r(Y), \qquad r'(Y) > 0.$$

- Implicitly differentiate first equation with respect to G:

- Implication: fiscal multiplier larger in more closed economy.
- Intuition: in open economy, part of stimulus leaks abroad.

Expansionary fiscal policy, algebraic

- IS curve and MP curve give two equations in two unknowns r, Y:

$$Y = \frac{C_0 + I_0 + G - (C_1 + I_1)\,T}{1 - C_1 - I_1} + \frac{(I_2(r) + N(r))}{1 - C_1 - I_1}, \quad I_2'(r), N'(r) < 0,$$
$$r = r(Y), \quad r'(Y) > 0.$$

- Implicitly differentiate first equation with respect to G:

$$\begin{aligned}
\frac{\partial Y}{\partial G} &= \frac{1}{1 - C_1 - I_1} + \left(\frac{I_2'(r) + N'(r)}{1 - C_1 - I_1}\right)\frac{\partial r}{\partial Y}\frac{\partial Y}{\partial G} \\
&= \left[1 - \left(\frac{I_2'(r) + N'(r)}{1 - C_1 - I_1}\right) r'(Y)\right]^{-1} \frac{1}{1 - C_1 - I_1} \\
&< \left[1 - \left(\frac{I_2'(r)}{1 - C_1 - I_1}\right) r'(Y)\right]^{-1} \frac{1}{1 - C_1 - I_1} = \left.\frac{\partial Y}{\partial G}\right|_{\text{closed economy}}.
\end{aligned}$$

- Implication: fiscal multiplier larger in more closed economy.
- Intuition: in open economy, part of stimulus leaks abroad.

Outline

1. Overview
2. Exchange rates (see Mankiw chapter 6)
3. Exchange rates, interest rates, and capital flows
4. IS-MP
5. Application: tax policy and net exports

TCJA 2017

- Tax Cut and Jobs Act of 2017 (TCJA) reduced personal taxes and corporate tax rate.

- Two channels through which TCJA affects net exports:

  1. Lower taxes $\Rightarrow$ higher domestic demand $\Rightarrow$ Fed raises policy rate $\Rightarrow$ exchange rate appreciates $\Rightarrow$ net exports fall.

  2. Lower corporate tax $\Rightarrow$ lower tax on capital $\Rightarrow$ after-tax domestic return rises $\Rightarrow$ foreign investors buy U.S. assets $\Rightarrow$ exchange rate appreciates $\Rightarrow$ net exports fall.

Corporate taxes and net exports

- Ignore inflation for simplicity.
- User cost return with corporate income tax from last week's homework:

$$Return = \frac{(1-\tau)\,F_K\,(K_t) + p^K_{t+1}\,(1-\delta)}{p^K_t}.$$

  Note: *Return* is endogenous return on investment.

- *Return* rises when tax falls if K_t fixed:
  $\partial Return/\partial\tau = -F_K(K_t)/p^K_t < 0$.
- Interest parity: $Return > Return^*$ $\Rightarrow$ capital inflows and exchange rate appreciation.
- Exchange rate appreciation $\Rightarrow$ net exports fall.
- Capital inflows finance increase in capital stock.

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