The Mundell-Fleming-Tobin Model

Lecture 11, ECON 4330

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(adapted slides from A. Rødseth & N. Ellingsen)

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Outline

Literature

Rødseth 3.1 and 6.1-6.4

Policy regimes: Targets at different levels

Welfare of population, economic stability

$\Leftarrow$ Price stability, low unemployment

$\Leftarrow$ Inflation rate 2%, price of dollar 7.15 kr

$\Leftarrow$ Day to day targets: Interest rate, exchange rate, quantity of money, central bank credit

Policy regimes: Targets at different levels

Welfare of population, economic stability

$\Leftarrow$ Price stability, low unemployment

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$\Leftarrow$ Day to day targets: Interest rate, exchange rate, quantity of money, central bank credit

- only two can be set independently
- if UIP, only one can be set independently

Monetary policy regimes in Norway

Period	System	Exogenous variables
1945-1971	Fixed (USD) Bretton-Woods	E and i
1971-1986	Fixed (European baskets)	E and i
1987-1991	Fixed (European baskets)	E and F_g
1992-2001	Floating (Restoration rule)	i and F_g
2001-	Floating (Inflation target)	i and F_g

The financial balance sheets

In order to address the various monetary policy options we need to introduce money

$\Rightarrow$ understand how the interest rate is determined if the CB uses M or B as policy instruments

Sector Asset	Private	Government	Foreign	Sum
money (kr)	M	$-M$	0	0
kr bonds	B	$-B$	0	0
\$ assets	F_p	F_g	F_*	0
Net assets	$M + B + EF_p$	$EF_g - M - B$	EF_*	0

Simplifying assumptions:

- foreigners don't hold any money and no kroner bonds
- domestic residents don't hold foreign money

Demand for money and domestic bonds

Reduced form money demand function:

$$\frac{M}{P} = m(i, Y) \qquad \text{with } m_i < 0, m_Y > 0 \tag{1}$$

Underlying assumptions

- money is used for transaction purposes, depends on economic activity (GDP) Y, $m_Y > 0$
- holding money means foregone interest i, $m_i < 0$

Demand for bonds:

$$\frac{B}{P} = W_p - f(r, W_p) - m(i, Y) \tag{2}$$

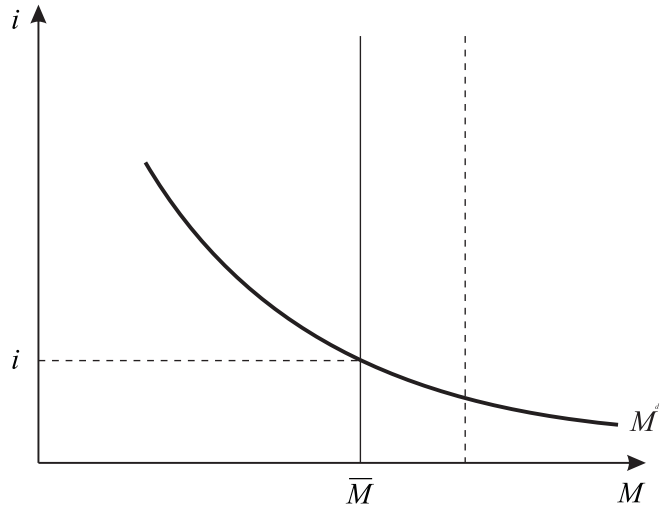
Other equilibrium conditions as in lecture 10, simplified according to the assumptions stated on the previous slide. Also, we hold Y constant for now, as well as P.

Exogenous and endogenous variables in six policy regimes

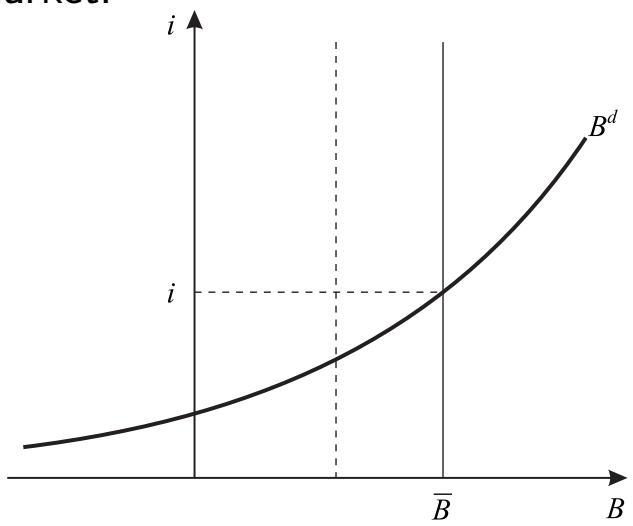
Regime		Exogenous	Endogenous
Fixed exchange rate:			
I	Fixed interest rate	E, i	F_g, M, B
II	No sterilization	E, B	F_g, M, i
III	Full sterilization	E, M	F_g, B, i
Floating exchange rate:			
IV	Fixed interest rate	F_g, i	E, M, B
V	No sterilization	F_g, B	E, M, i
VI	Full sterilization	F_g, M	E, B, i

Equilibrium in the money market, bond market, and the FX market

Money market:



Bond market:



$$M = Pm(i, Y) \tag{1}$$

$$\frac{B}{P} = W_p - f\left[r(i, E), W_p(E)\right] - m(i, Y) \tag{2}$$

FX market:

$$F_g = -\frac{P}{E} f\left[r(i, E), W_p(E)\right] - F_* \tag{3}$$

Monetary policy under different regimes

Floating exchange rate

Sterilized FX intervention

In the previous lecture, we held i constant. A FX intervention $\mathrm{d}F_g > 0$ then lead to depreciation

- in the present extended model, i is endogenous
- but the CB can keep it on target by controlling M
  - (1) implies: i constant if M constant

  $\Rightarrow$ this is called a "sterilized intervention"

  $\Rightarrow$ it means that the CB neutralizes the side effect of FX interventions on the interest rate with a countervailing intervention in the bond market
- holding M constant is achieved by selling bonds to finance $\mathrm{d}F_g > 0$, rather than money
- CBs budget constraint:

$$EF_g - B - M = EF_{g0} - B_0 - M_0 \qquad \Rightarrow \qquad \mathrm{d}M = E\mathrm{d}F_g - \mathrm{d}B$$

- to achieve $\mathrm{d}M = 0$ the CB must offset $\mathrm{d}F_g > 0$ with $\mathrm{d}B > 0$

Unsterilized FX intervention

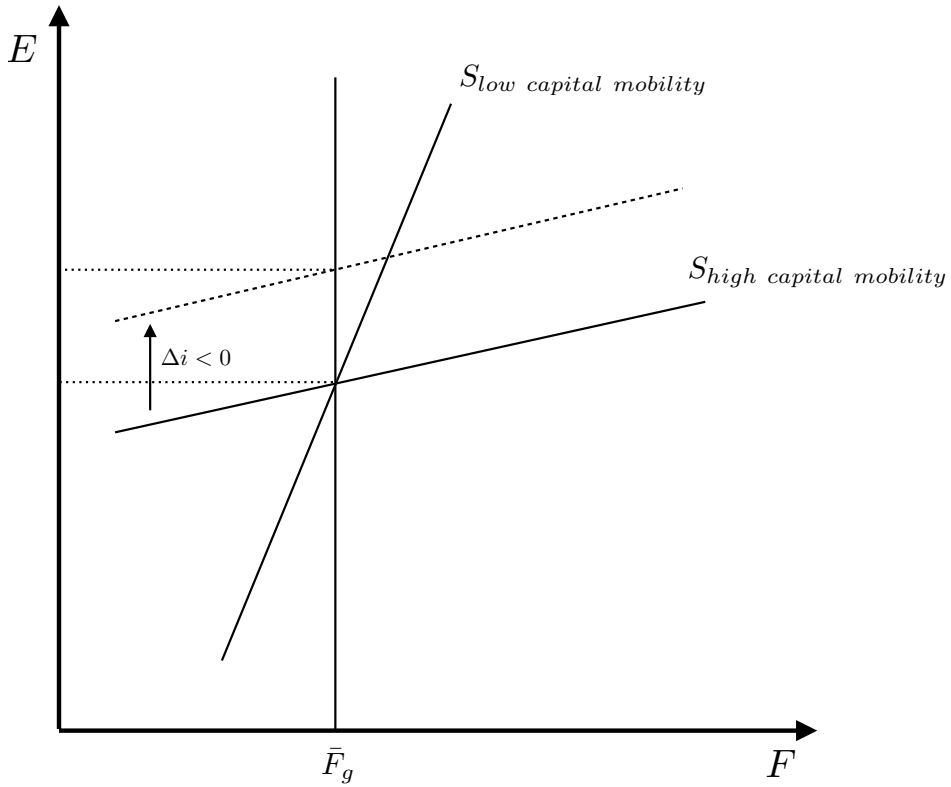
In an *unsterilized intervention* $\mathrm{d}F_g > 0$

- CB holds B constant: $\Rightarrow \ \mathrm{d}M = E\mathrm{d}F_g$
- from (1): i must fall
- public wants to buy more foreign assets
- excess demand leads kr to depreciate even more

FX interventions and capital mobility

When capital mobility is high

- sterilized interventions become ineffective (FX supply curve becomes flat)
- but unsterilized interventions still work, because they also affect *i*



Expansionary monetary policy under floating exchange rate

Expansionary monetary policy means that the CB wants to increase the money supply

- effectively, this is always achieved by purchasing bonds
- generally, how much a given amount of bond purchases $-\mathrm{d}B > 0$ increases M depends on whether the public uses the revenue from bond sales to also buy foreign currency
- CBs budget constraint: $\mathrm{d}M = E\mathrm{d}F_g - \mathrm{d}B$

When F_g is fixed, bonds can only be exchanged for money

- $\mathrm{d}M = E\mathrm{d}F_g - \mathrm{d}B = -d\mathrm{B}$
- targeting M or B has identical effects
- (1) yields the induced interest rate decline
- (3) implies depreciation

$\Rightarrow$ Policy regimes V, VI are indistinguishable

- if there is no intervention in the FX market, then there is also no role for sterilization

Fixed exchange rate

Expansionary monetary policy with fixed exchange rate

When E is fixed, CB has to use adjust F_g to keep it there when the interest rate changes

- $\mathrm{d}M = E\mathrm{d}F_g - \mathrm{d}B \quad \not\Rightarrow \quad \mathrm{d}M = -\mathrm{d}B$
- targeting M (full sterilization) or B (no sterilization) has different effects

$\Rightarrow$ different from floating exchange rate regime and different from closed economy

Expansionary monetary policy under regime III

Expansionary monetary policy $\mathrm{d}\bar{M} > 0$ with sterilization (III, M targeted)

- increase in M achieved through purchases of B
- (1) yields the induced interest rate decrease: $\frac{\mathrm{d}i}{\mathrm{d}M} = \frac{1}{Pm_i}$
- public buys \$ assets, $\mathrm{d}F_g < 0$ to hold E constant
- CB sells FX for bonds

$\Rightarrow$ $\mathrm{d}\bar{M} < -\mathrm{d}B$

$\Rightarrow$ effectively, CB takes control of the interest rate by sterilizing $\mathrm{d}F_g$ with bond purchases

However,

- greater capital mobility means larger loss of FX reserves
- perfect capital mobility means control over i cannot be sustained

Monetary policy under regime II

Expansionary monetary policy $\mathrm{d}\bar{B} < 0$ without sterilization (II, B targeted)

- increase in M achieved through purchases of B
- greater money supply lowers i
- (3) implies capital outflow, exchanged for money because B is fixed
- differentiating (2) gives induced net interest rate decrease $\frac{\mathrm{d}i}{\mathrm{d}\bar{B}} = -\frac{1}{f_r + Pm_i}$

$\Rightarrow \mathrm{d}M < -\mathrm{d}\bar{B}$

$\Rightarrow$ smaller impact on i and F_g

With higher capital mobility, impact on i becomes smaller

Summary of policy regimes

Floating exchange rates

- FX intervention: $dF_g > 0$
  - sterilized: depreciation, no effect on i
  - unsterilized: more depreciation, $i \downarrow$
- expansionary monetary policy: $dM > 0$ or $dB < 0$
  - depreciation, $i \downarrow$
  - $dF_g = 0 \Rightarrow dM = -dB$, no role for sterilization

Fixed exchange rates

- devaluation/revaluation not considered here
- expansionary monetary policy: $dM > 0$ or $dB < 0$
  - sterilized: $i \downarrow$, loss of FX reserves
  - unsterilized: $i \downarrow$, loss of FX reserves, but smaller effects on both than with sterilization

With perfect capital mobility, CB has only one effective policy tool

- it cannot fix E or control FX reserve *and* target i, M, or B

The Mundell-Fleming-Tobin model

The MFT model: Intro

Purpose

- analyze effects of policies on Y
  - in the short run, P still fixed
- pave the way to the medium and long-run equilibrium (next lectures)
  - where P becomes endogenous and CBs policy objective of inflation targeting can be analyzed

Mundell - Fleming - Tobin model

- Keynesian model
- short-run equilibrium
  - Y determined by demand
  - prices fixed
- small open economy IS-LM model
- portfolio approach to financial side

If you want to refresh your knowledge of the basic IS-LM model, Mankiw's "Macroeconomics" book is an easy read (Ch 10,11 in 5th edition)

MFT model: The real side

$$Y = C(Y_p, W_p, \rho, \rho_*) + I(\rho, \rho_*) + G + X(R, Y, Y_*) \quad (4)$$

$$Y_p = Y - \rho_* \frac{EF_*}{P} - T \quad (5)$$

$$\rho = i - p_e \quad (6)$$

$$W_p = \frac{B_0 + EF_{p0} + M_0}{P} \quad (7)$$

$$R = \frac{EP_*}{P} \quad (8)$$

- consumption C
  - $0 < C_{Y_p} < 1$, $C_W > 0$, $C_\rho < 0$, $C_{\rho_*} < 0$
- investment I
  - $I_\rho < 0$, $I_{\rho_*} < 0$
- net exports $X = Z_* - RZ$
  - $X_R > 0$ (assumed), $X_Y < 0$
- output Y, government purchases G, disposable income Y_p, net transfers to government T
- real interest rate ρ, nom. interest rate i, expected change in price level p_e, real exch. rate R

MFT - Financial Side

$$
\begin{aligned}
r &= i - i_* - e_e(E) && (9)\\
\frac{B}{P} &= W_p - f(r, W_p) - m(i, Y) && (10)\\
\frac{M}{P} &= m(i, Y) && (11)\\
\frac{EF_p}{P} &= f(r, W_p) && (12)\\
F_g &= -F_p - F_* && (13)
\end{aligned}
$$

- as before $f_r < 0$, $0 < f_W < 1$, $e_e' < 0$
- simplification as before:
  - home's residents hold domestic currency, domestic and foreign bonds
  - foreign residents hold neither bonds nor currency from home

The model's variables

- given from abroad: P_*, i_*, Y_*, ρ_*
- predetermined: P, p_e, F_*, B_0, F_{p0}
- policy variables
  - fiscal: G, T (exogenous)
  - monetary: E, F_g, i, B, M (2 exogenous, 3 endogenous)
- remaining endogenous: Y, Y_p, R, r, ρ, W_p, F_p

Forex market

Recall previous lectures:

- equilibrium condition: $F_g + F_p + F_* = 0$
- or after inserting demand function

$$F_g + (P/E)f(i - i_* - e_e(E), (B_0 + EF_{p0})/P) + F_* = 0$$

Fixed:

- E, i exogenous, F_g endogenous
- lower i means loss of reserves, F_g down
- more capital mobility means greater loss of reserves

Floating:

- F_g, i exogenous, E endogenous
- lower i means depreciation (E up)
- more capital mobility means stronger depreciation

Reduced-form equilibrium conditions

Asset markets (financial side):

- money market (11) gives **LM curve**:

$$\frac{M}{P} = m(\underset{-}{i}, \underset{+}{Y}) \tag{14}$$

- bond market: inserting (5) into (10) gives us **BB curve**:

$$\frac{B}{P} = W_p(E) - f(\underset{-}{i}, E) - m(\underset{-}{i}, \underset{+}{Y}) \tag{15}$$

  - $B_E > 0$ assumed (recall lecture 10, regressive expectations & portfolio composition effect)

- forex market: inserting (12) in (13) gives **FX curve**:

$$F_g + F_p(\underset{-}{i}, \underset{-}{E}) + F_* = 0 \tag{16}$$

  - $F_{pE} < 0$ assumed (recall lecture 10)

Reduced-form equilibrium conditions

Goods market (real side):

▸ ISLM basics

- inserting (5)-(8) into (4) gives **IS curve**:

$$Y = C(\underset{+}{Y}, \underset{+(?)}{E}, \underset{-}{i}) + I(\underset{-}{i}) + G + X(\underset{+(?)}{E}, \underset{+}{Y}) \tag{17}$$

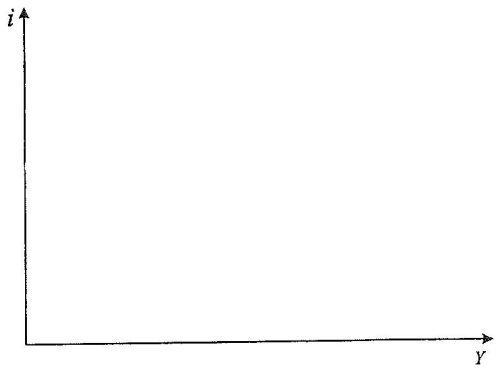
- $C_E, X_E > 0$ assumed, but needs to be discussed
  - irrelevant for analysis of policy under fixed exchange rate regime (except for exchange rate interventions)

Fixed exchange rates

Equilibrium in (i,Y) space with fixed exchange rate

Equilibrium in (i, Y) space

- determined by intersection of LM, BB, and IS curve
- since E is fixed, we can ignore the FX market for now



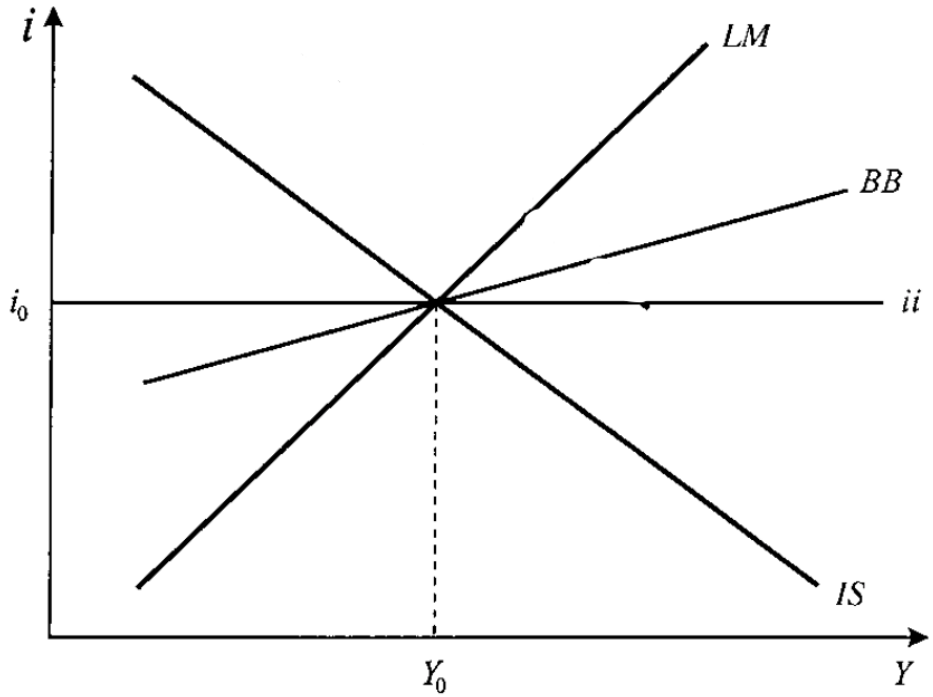
What do the curves look like?

$$\frac{\partial i}{\partial Y} = \frac{1-C_{Y_p}-X_Y}{C_\rho+I_\rho} < 0 \quad \text{from IS} \quad (18)$$

$$\frac{\partial i}{\partial Y} = -\frac{m_Y}{m_i} > 0 \quad \text{from LM} \quad (19)$$

$$\frac{\partial i}{\partial Y} = -\frac{m_Y}{f_r+m_i} > 0 \quad \text{from BB} \quad (20)$$

Equilibrium in (i,Y)-space with fixed exchange rate

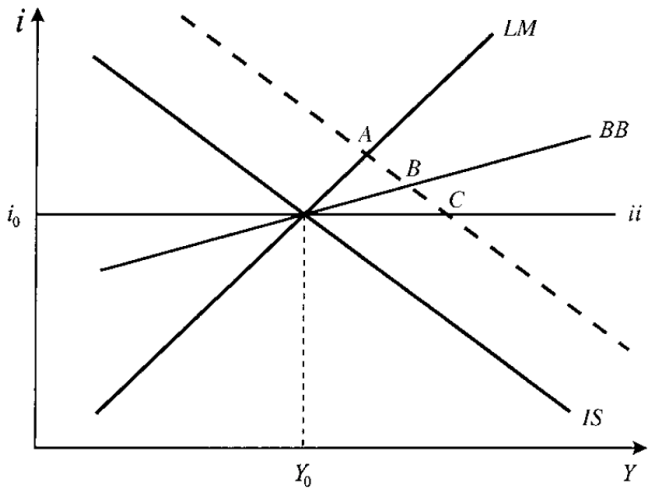


How do we find the new equilibrium if there is an exogenous shock?

- depends on monetary policy regime: move along the original
  - LM curve if M is fixed
  - ii curve if i is fixed
  - BB curve if B is fixed
- the other curves have to shift

Fiscal policy

Shift in IS curve caused by $\mathrm{d}G > 0$



i fixed: new equilibrium C

- $Y \uparrow \rightarrow M \uparrow$, bonds exchanged for money

B fixed: new equilibrium B

- $Y \uparrow \rightarrow M, i \uparrow$, foreign bonds exchanged for money
- increase in i slows down Y

M fixed: new equilibrium A

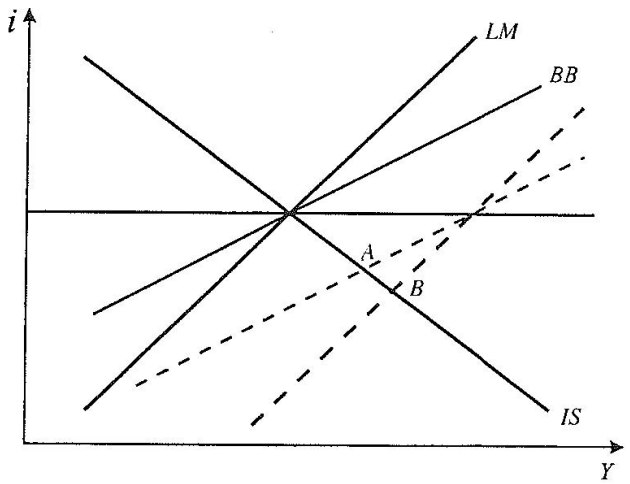
- $Y \uparrow \rightarrow i \uparrow$, foreign bonds exchanged for dom. bonds
- stronger increase in i slows down Y even more

Fiscal policy effect on Y is strongest if i is fixed

Monetary policy

Open market operation dM=-dB

- shifts BB and LM curve by same amount (at first)
- adjustment to new equilibrium depends on policy regime



B targeted (no sterilization): new equilibrium A

- $i \downarrow$ to equilibrate goods market
- foreign bonds bought with domestic money, LM shifts back at little bit
- M adjusts $\uparrow$, slows down $i \downarrow$ and $Y \uparrow$

M targeted (sterilization): new equilibrium B

- $i \downarrow$ to equilibrate goods market
- foreign bonds bought with domestic bonds
- BB shifts down further, no slowdown of i and Y

Expansionary monetary policy effect on Y is stronger if intervention is sterilized

Sterilization or not? Effects of shocks

How do the two regimes contribute to output stability in the presence of

- real demand shocks: e.g. shocks to $C()$, or ΔG (generally, shifts of the IS curve) ?
- monetary shocks: e.g. shocks to $L()$, or ΔM (shifts of the LM curve) ?
- FX shocks: e.g. shocks to $f()$, e_e (shifts of the BB curve) ?

Sterilization

- reduces impact of real demand shocks
  - feeds demand shocks fully into changes in i, which dampens the output effect
- amplifies money demand shocks
  - direct effect on i fed fully into goods market
  - sterilization prevents interest rate effect to be mitigated by change in money holdings
- fully removes impact of FX shocks by preventing change in i

$\Rightarrow$ sterilization is good if demand shocks or FX shocks are the greatest concern

- but it comes with greater changes in FX reserves and possibly i
- loses power if capital mobility is high

Effects of a devaluation

Effects of a devaluation $\mathrm{d}E > 0$ on the IS curve

$$Y = C\left(Y - \rho_* \frac{EF_*}{P} - T, \frac{B + EF_p}{P}, i - \dot{p}_e, \rho_*\right) + I(i - \dot{p}_e, \rho_*) + G + X\left(\frac{EP_*}{P}, Y, Y_*\right)$$

are ambiguous:

- interests payments on foreign debt increase if $F^* = -F_g - F_p > 0$, reducing consumption
- real wealth goes up if $F_p > 0$, increasing consumption
- imports become more expensive, leaving less to be spent on home goods
- but home goods become relatively cheaper, shifting demand towards them

In what follows, we assume $\frac{\mathrm{d}Y}{\mathrm{d}E} = \frac{\mathrm{d}C}{\mathrm{d}E} + \frac{\mathrm{d}X}{\mathrm{d}E} > 0$. But in theory this must not always hold (Lizondo and Montiel, 1989)

Floating exchange rates

Equilibrium with floating exchange rate

When the exchange rate is floating, it will adjust to changes in the interest rate

- from the FX curve:

$$E \rightarrow E(i, i_*, P, F_g) \tag{21}$$

- $E_i < 0$: higher interested rate leads to greater demand for domestic currency $\rightarrow$ appreciation

Y depends on E through consumption and net exports, the relationship between Y and i (i.e. the IS curve) now looks different

- inserting (21) in (4) gives **ISFX curve**

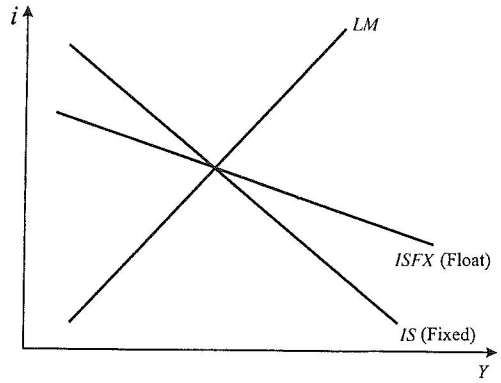
$$Y = C(Y, E(i), i) + I(i) + G + X(E(i), Y) \tag{22}$$

- with $\frac{dY}{dE} > 0$ (cp. previous slide), ISFX is flatter than IS curve
  - depreciation spurs Y through increased demand for home goods

Policy under floating exchange rate

With $\frac{dY}{dE} > 0$, ISFX is flatter than IS curve

- but still downward-sloping
- smaller interest rate leads to greater change in output



But it's important to keep in mind that $\frac{dY}{dE}$ can be negative and hence it is possible that cutting interest rate leads to output contraction! This is more likely if

- foreign currency debt is high
- the trade deficit is large
- substitution is weak between home and foreign goods
- direct interest rate effects are weak

Policy under floating exchange rate

Money market: BB and LM curves coincide in the (i, Y) space because $\mathrm{d}M = -\mathrm{d}B$ $(\mathrm{d}F_g = 0)$

Fiscal policy: $\mathrm{d}G > 0$

- i fixed: similar outcome as with fixed E
- M fixed:
  - positive but smaller effect on Y, i as with fixed E
  - $i \uparrow \rightarrow$ appreciation $\rightarrow$ slows down $Y \uparrow$

Monetary policy $\mathrm{d}M = -\mathrm{d}B > 0$

- larger effect on Y
- $i \downarrow \rightarrow$ depreciation $\rightarrow$ reinforces $Y \uparrow$

Fixed versus flexible: Effects of shocks

When M is fixed

- demand shocks are dampened if E is floating
  - buffered by appreciation/depreciation if shock is positive/negative
- money demand shocks are amplified if E is floating
  - spurred by depreciation/appreciation if shock is positive/negative
- FX shocks can be fully isolated if E is fixed (and there is sterilization) but are passed to goods market if E is floating

Floating E insures better against real demand shock, fixed E insures better against monetary shocks and foreign shocks

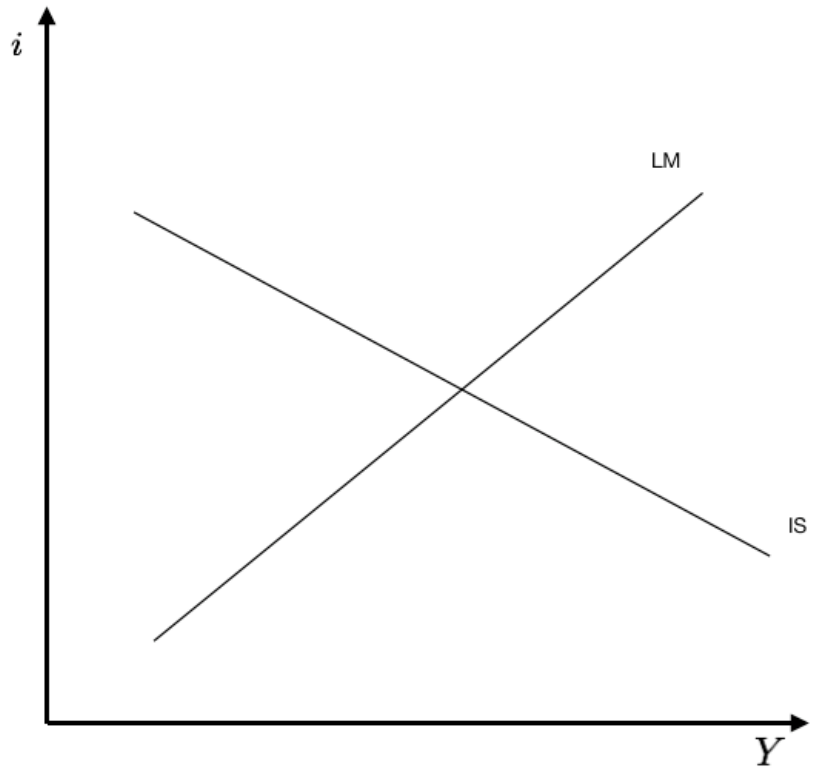
Fixed versus flexible: Effects of shocks with high capital mobility

When capital mobility is high

- points 1,2 above get amplified (E becomes more responsive)
- FX shocks
  - fixed E: sterilization becomes impossible, FX shocks transmitted to the goods market through i. Only fiscal policy can be used to counteract.
  - floating E: monetary policy can be used to distribute FX shocks partly or fully into in E rather than i

However, such "activist" monetary policy implies fluctuations in M, which in the long run can contribute to price-level instability

IS-LM basics



IS curve:

$$Y = C(Y, i) + I(i) + G + X$$

LM curve:

$$\frac{M}{P} = L(Y, i)$$

back