Foundations of Modern Macroeconomics Second Edition

Chapter 10: The open economy

Ben J. Heijdra

Department of Economics, Econometrics & Finance
University of Groningen

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Outline

1. Open economy IS-LM-BP-AS model
   - IS-LM-BP model
   - AS for the open economy
   - AD-AS for the open economy
2. International shock transmission
3. Anticipation effects

Aims of this lecture

- Opening up the IS-LM model (sequel to Chapter 1 material): Mundell-Fleming.
- Fiscal and monetary policy in the open economy.
  - Degree of capital mobility.
  - Exchange rate system (fixed, flexible, managed).
- Two-country IS-LM-AS models.
  - Shock transmission.
  - International policy coordination.
- Open economy perfect foresight models (sequel to Chapter 4 material).
  - Role of price stickiness.
  - Degree of capital mobility.
  - Monetary accommodation.

National income and monetary accounting (1)

- For the open economy we have from the national accounts:

$$Y \equiv C + I + G + (EX - IM) \tag{S1}$$

  - Y is aggregate output.
  - C is private consumption.
  - I is investment.
  - G is government consumption.
  - EX is exports (demand by RoW for our products).
  - IM is imports (demand by us for RoW's products).

- We often write:

$$Y \equiv A + (EX - IM)$$

  - A is absorption; $EX - IM$ is *net* exports.

National income and monetary accounting (2)

- Remember output measurement:
  - Gross Domestic Product (GDP): output produced within the country ("produced where?").
  - Gross National Product (GNP): output produced by the country's residents domestic ("produced by whom?").
  - Difference: net factor payments from abroad.
- We can add transfers (TR) and deduct taxes (T) from (S1) to get:

$$\underbrace{Y + TR - T}_{(a)} \equiv C + I + (G - T) + (\underbrace{EX + TR - IM}_{(b)}) \quad \text{(S2)}$$

  - (a) Disposable income of residents.
  - (b) Current account CA (of the BoP).

National income and monetary accounting (3)

- Private sector saving:

$$S \equiv Y + TR - T - C \tag{S3}$$

- Combining (S2) and (S3):

$$(S - I) + (T - G) \equiv (EX + TR - IM) \equiv CA$$

  - Current account surplus is sum of saving surpluses of private and public sectors.
  - CA measures additions to net external assets ($CA > 0$ means that domestic country is **lending to** RoW):

$$\begin{aligned} \Delta NFA &\equiv CA \\ &\equiv (S - I) + (T - G) \end{aligned}$$

National income and monetary accounting (4)

- Now some monetary accounting: how does ΔNFA affect the monetary side of the economy?
  - Look at ΔNFA^{cb} (cb stands for Central Bank).
  - Stylized balance sheet:

Balance Sheet of the Central Bank

Assets		*Liabilities*	
Net foreign assets	NFA^{cb}		
Domestic credit	DC	High powered money	H

National income and monetary accounting (5)

- Continued.
  - NFA^{cb}: foreign exchange reserves less liabilities to foreign official holders.
  - DC: securities held by CB (e.g. government bonds), loans, other credit.
  - H: stock of high-powered money ("base money"):

$$H \equiv C^P + RE$$

    where C^P is currency and RE is commercial bank deposits held at CB.
  - by definition we get in first differences:

$$\Delta NFA^{cb} \equiv \Delta H - \Delta DC \qquad \text{(S4)}$$

National income and monetary accounting (6)

- Expression (S4) yields important insights:
  - If CB intervenes in foreign exchange market then, barring changes in DC, this will affect (base) money supply: $\Delta NFA^{cb} \equiv \Delta H$.
  - But CB can break link between NFA^{cb} and H temporarily by *sterilization*: manipulate DC to keep base money supply unchanged ($\Delta NFA^{cb} \equiv -\Delta DC$ so that $\Delta H = 0$). **Example**: sale of forex by CB $\Longrightarrow \Delta NFA^{cb} < 0$, expansionary *open market operation* (purchase of domestic bonds) $\Longrightarrow$ $\Delta DC > 0$.
- Final remark: in fractional reserve system we have that money supply is proportional to base money, i.e. $M^S = \mu H$ and thus $\Delta M^S = \mu \Delta H$.

Open economy IS-LM model (1)

- The IS curve for the open economy can be written as follows:

$$
\begin{aligned}
Y &= A(\underset{-}{r}, \underset{+}{Y}) + G + X(\underset{-}{Y}, \underset{+}{Q}), \\
Q &\equiv \frac{EP^*}{P}
\end{aligned}
$$

- $A(r, Y)$ is part of domestic absorption depending on r and Y; partial derivatives $A_r < 0$ (investment) and $0 < A_Y < 1$ (MPC).
- $X(Y, Q)$ is net exports; partial derivatives $X_Y < 0$ (import demand) and $X_Q > 0$ (Marshall-Lerner condition).
- Q is the relative price of foreign goods:
  - E is nominal exchange rate (dimension Euro/US$).
  - P is domestic price level (dimension Euros).
  - P^* is foreign price level (dimension US$).

Open economy IS-LM model (2)

- The LM curve for the open economy is represented by:

$$\begin{aligned} M^D/P &= L(\underset{-}{r}, \underset{+}{Y}) \\ M^S &= \mu\left[NFA^{cb} + DC\right] \\ M^D &= M^S = M \end{aligned}$$

- "Supply side." Horizontal aggregate supply curves:

$$P = P^* = 1$$

Capital mobility and economic policy (1)

- Alternative assumptions regarding "financial openness" of an economy:
  - Capital immobility: no trade in financial assets at all (1940s, early 1950s).
  - Perfect capital mobility: no barriers; equalization of yields (1980s onward).
  - imperfect capital mobility: intermediate case
- Balance of payments:

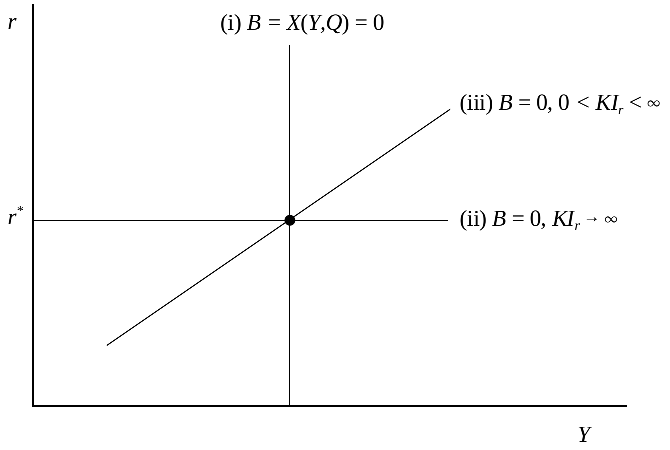
$$B \equiv X(Y, Q) + KI(r - r^*) \equiv \Delta NFA^{cb}$$

  - B is balance of payments.
  - X is trade account (ignoring international transfers, TR).
  - KI is net capital inflow'. For $KI > 0$ domestic agents sell more assets to RoW than they are buying from us; net borrowing from RoW.
  - r^* is interest rate in RoW.

Capital mobility and economic policy (2)

- Cases mentioned above:
  - Capital immobility:
    - $KI(r - r^*) \equiv 0$ regardless of r and r^*.
    - BoP equilibrium ($B = 0$) identical to trade balance equilibrium ($X(Y, Q) = 0$).
  - Perfect capital mobility:
    - Arbitrage ensures that $r = r^*$ (represented by $KI_r \to +\infty$).
  - Imperfect capital mobility:
    - Differences in r and r^* can persist (represented by $0 < KI_r \ll +\infty$).
  - Note: In latter two cases, BoP equilibrium is such that $X(Y, Q) = -KI(r - r^*)$.
- Three cases are drawn in Figure 10.1.

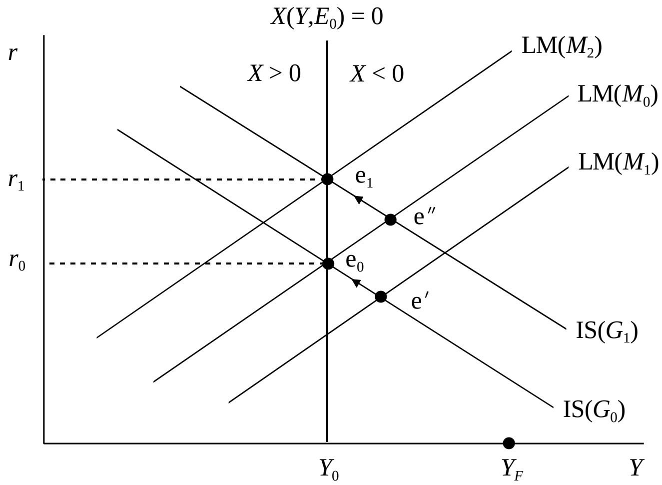
Figure 10.1: The degree of capital mobility and the balance of payments



Immobile capital and fixed exchange rates (1)

- Assumptions:
  - Capital immobile: $KI(r - r^*) \equiv 0$.
  - Monetary authority maintains exchange rate at E_0.
- Case is drawn in **Figure 10.2**.
  - IS downward sloping, LM upward sloping, $X\left(Y, E_0\right) = 0$ line vertical.
  - To right (left) of $X\left(Y, E_0\right) = 0$ imports too high (low) and $B = X < 0$ (> 0).
  - Initial equilibrium at point e_0.

Figure 10.2: Monetary and fiscal policy with immobile capital and fixed exchange rates



Immobile capital and fixed exchange rates (2)

- Monetary policy:
  - Open market operation: purchase of bonds by CB, $\Delta DC > 0$.
  - Money supply goes up (from M_0 to M_1).
  - LM to the right; economy to point e′.
  - At e′ there is excess demand for forex.
  - To keep exchange rate constant, CB must intervene (sell forex).
  - Money supply *gradually* falls; LM shifts to left.
  - Economy back to e_0.
  - Conclusion: no long-run effect on r and Y.

Immobile capital and fixed exchange rates (3)

- Fiscal policy:
  - Bond financed increase in government consumption.
  - IS to the right; economy to point e″.
  - At e″ there is excess demand for forex.
  - To keep exchange rate constant, CB must intervene (sell forex).
  - Money supply gradually falls; LM shifts to left.
  - Economy moves to e_1.
  - Conclusion: no long-run effect on Y but r higher.
  - Crowding out of investment.

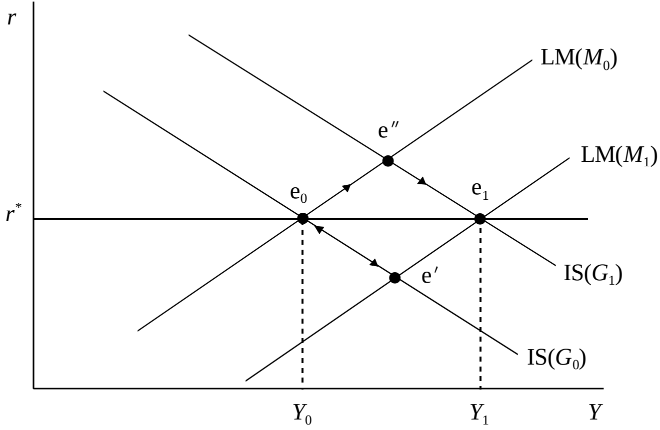
Perfectly mobile capital and fixed exchange rates (1)

- Assumptions:
  - Capital perfectly mobile: $r = r^*$.
  - Monetary authority maintains exchange rate at E_0.
  - BP curve is horizontal in **Figure 10.3**.
  - Economy initially at e_0.
- Monetary policy:
  - OMO increases DC and money supply; LM to right.
  - At e′ excess demand for forex (investors want to buy foreign assets).
  - CB intervenes and loses its foreign reserves; LM back.
  - Adjustment is *instantaneous*, so monetary policy ineffective even in short run.

Perfectly mobile capital and fixed exchange rates (2)

- Fiscal policy:
  - Bond financed increase in government consumption.
  - IS to the right; economy to point e''.
  - At e'' there is excess supply of forex (investors dump foreign assets).
  - To keep exchange rate constant, CB must intervene (buy forex).
  - Money supply increases; LM to the right, economy moves to e_1.
  - Adjustment is *instantaneous*: no effect on r but Y higher.
  - Fiscal policy highly effective.

Figure 10.3: Monetary and fiscal policy with perfect capital mobility and fixed exchange rates



Perfect capital mobility and flexible exchange rates (1)

- The flexible exchange rate ensures BoP equilibrium:

$$B \equiv \Delta NFA^{cb} = 0 \qquad \Leftrightarrow$$

$$X(Y, E) + KI(r - r^*) = 0$$

  - Imports: cause demand for forex.
  - Exports: cause supply of forex.
  - Capital imports: cause supply of forex.
  - Recall: no exchange rate intervention by CB, so stock of forex in hands of CB constant. Change in DC affects money supply. Money supply can be controlled.
- Focus on case with perfect capital mobility (PCM).

Perfect capital mobility and flexible exchange rates (2)

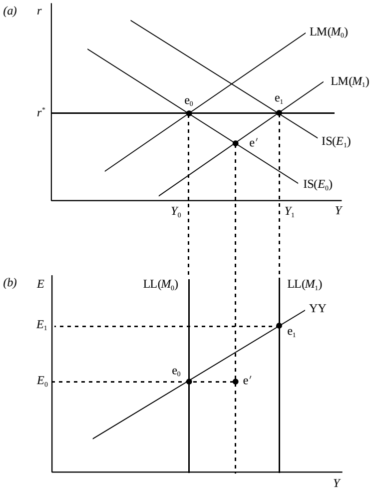
- PCM implies $r = r^*$ so model simplifies to:

$$Y = A(r^*, Y) + G + X(Y, E) \qquad \text{(YY)}$$

$$M = L(r^*, Y) \qquad \text{(LL)}$$

- Monetary policy:
  - See **Figure 10.4**.
  - OMO increases DC and money supply; LM to right.
  - At point e′ there is excess demand for forex.
  - Domestic currency depreciates; IS to right.
  - Hence: *instantaneous* adjustment from e_0 to e_1.
  - Monetary policy highly effective!

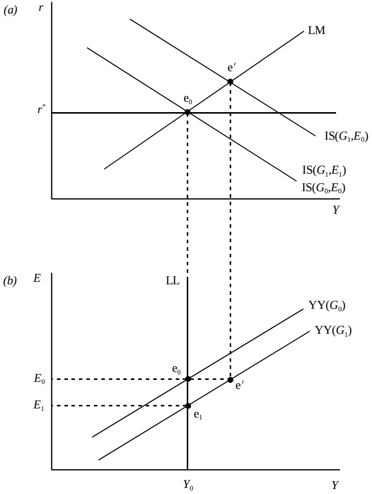
Figure 10.4: Monetary policy with perfect capital mobility and flexible exchange rates



Perfect capital mobility and flexible exchange rates (3)

- Fiscal policy:
  - See **Figure 10.5**.
  - Bond financed increase in government consumption; IS to right.
  - At point e′ there is excess supply of forex.
  - Domestic currency appreciates; IS to left.
  - Hence: in panel (a) the economy stays at e_0; in panel (b) it moves from e_0 to e_1.
  - fiscal policy completely ineffective at influencing output!

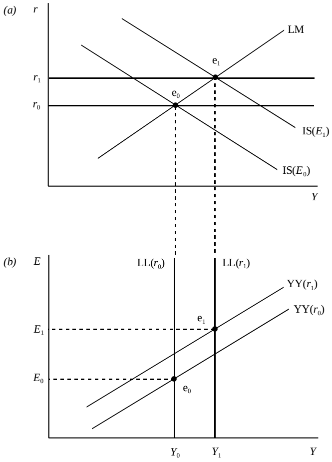
Figure 10.5: Fiscal policy with perfect capital mobility and flexible exchange rates



Perfect capital mobility and flexible exchange rates (4)

- Insulation property:
  - Flexible exchange rates insulate small open economy from foreign shocks (provided r^* is unaffected).
  - Example: RoW spending boom. Our exports rise, YY curve to the right, exchange rate appreciates, no effect on output. Shock not transmitted to quantities.
- For global shocks no insulation property:
  - Example: boost in RoW driving up world interest rate, r^*
  - See **Figure 10.6**.
  - LL to right; YY up; domestic currency depreciates; output increases.

Figure 10.6: Foreign interest rate shocks with perfect capital mobility and flexible exchange rates



Summary open economy IS-LM-BP model

- Exchange rate regime matters a lot.
  - Completely fixed exchange rates.
  - Completely flexible exchange rates.
  - Intermediate case: *managed float* (see below).
- Mobility of financial capital matters a lot.
  - No mobility.
  - Perfect mobility.
  - Intermediate case: *imperfect capital mobility* (see **Figure 10.7** and **Table 10.1**).

Figure 10.7: Monetary policy with imperfect capital mobility and flexible exchange rates

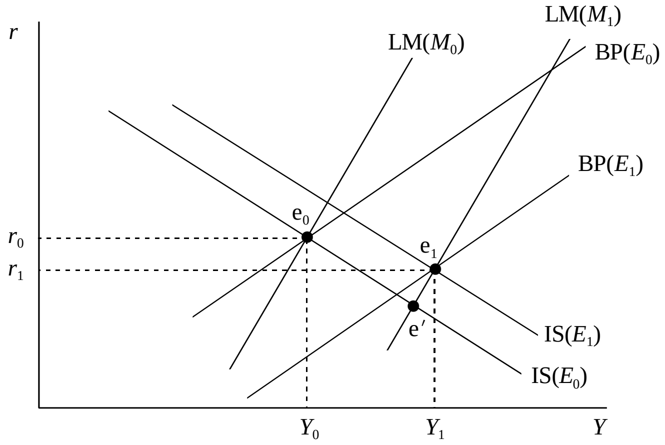


Table 10.1: Imperfect capital mobility under fixed and flexible exchange rates

	Flexible exchange rates		
	dG	dM	dr^*
dY	$-\frac{L_r X_Q / KI_r}{\lvert\Delta\rvert} \geq 0$	$\frac{X_Q(1-A_r/KI_r)}{\lvert\Delta\rvert} > 0$	$-\frac{L_r X_Q}{\lvert\Delta\rvert} > 0$
dr	$\frac{L_Y X_Q / KI_r}{\lvert\Delta\rvert} \geq 0$	$-\frac{X_Q(1-A_Y)/KI_r}{\lvert\Delta\rvert} \leq 0$	$0 < \frac{L_Y X_Q}{\lvert\Delta\rvert} \leq 1$
dE	$\frac{L_r X_Y / KI_r - L_Y}{\lvert\Delta\rvert} \lesseqgtr 0$	$\frac{1-A_Y-X_Y+A_r X_Y/KI_r}{\lvert\Delta\rvert} > 0$	$\frac{-A_r L_Y - L_r(1-A_Y-X_Y)}{\lvert\Delta\rvert} > 0$

Table 10.1: Imperfect capital mobility under fixed and flexible exchange rates (continued)

	Fixed exchange rates		
	dG	dE	dr^*
dY	$\frac{1}{\lvert\Gamma\rvert} > 0$	$\frac{X_Q(1-A_r/KI_r)}{\lvert\Gamma\rvert} > 0$	$\frac{A_r}{\lvert\Gamma\rvert} < 0$
dr	$-\frac{X_Y/KI_r}{\lvert\Gamma\rvert} \geq 0$	$-\frac{(1-A_Y)X_Q/KI_r}{\lvert\Gamma\rvert} < 0$	$0 < \frac{1-A_Y-X_Y}{\lvert\Gamma\rvert} \leq 1$
dM	$\frac{L_Y-L_rX_Y/KI_r}{\lvert\Gamma\rvert} \gtrless 0$	$\frac{\lvert\Delta\rvert}{\lvert\Gamma\rvert} > 0$	$\frac{A_rL_Y+L_r(1-A_Y-X_Y)}{\lvert\Gamma\rvert} < 0$

Supply side

- Assumed so far: horizontal AS curves in the domestic economy and in the RoW: $P = P^* = 1$ (constant).
- Adding the supply side important because:
  - "Microeconomic" foundation behind demand/supply curves.
  - Consistent treatment of cost-of-living indexes.
  - Used later to study international shock transmission.

Armington approach (1)

- Macroeconomic relations:

$$\begin{aligned} C &= C(Y) \\ I &= I(r) \end{aligned}$$

  - MPC between 0 and 1 ($0 < C_Y < 1$).
  - Investment depends negatively on cost of capital (interest rate) ($I_r < 0$).
  - Note: Part of C and I produced domestically, part imported.
- Armington approach to model components. Example: consumption.
  - C "constructed" out of C_d (domestic) and C_f (foreign) according to:

$$C = C_d^{\alpha} C_f^{1-\alpha}, \qquad 0 < \alpha < 1$$

  - Household faces prices P (domestic) and EP^* (foreign).

Armington approach (2)

- Continued.
  - Choose C_d and C_f to minimize expenditure for given C.
  - Solutions:

$$
\begin{aligned}
C_d &= \alpha\Omega_0 \left(\frac{EP^*}{P}\right)^{1-\alpha} C(Y) \\
C_f &= (1-\alpha)\Omega_0 \left(\frac{EP^*}{P}\right)^{-\alpha} C(Y) \\
P_C &\equiv \Omega_0 P^{\alpha} \left(EP^*\right)^{1-\alpha}
\end{aligned}
$$

  where $\Omega_0 \equiv [\alpha^{\alpha}(1-\alpha)^{1-\alpha}]^{-1} > 0$.
- Interpretation:
  - Ceteris paribus $C(Y)$, an increase in the **relative** price of foreign goods leads to an increase in C_d and a decrease in C_f (substitute to domestic goods).
  - P_C is the cost-of-living index, i.e. the unit cost of composite consumption.

Armington approach (3)

- We can use the same trick for investment and for government consumption:
  - Assume same α (as for C) for simplicity:

$$\begin{aligned} I &= I_d^{\alpha} I_f^{1-\alpha} \\ G &= G_d^{\alpha} G_f^{1-\alpha} \end{aligned}$$

  - Solutions:

$$I_d = \alpha\Omega_0 \left(\frac{EP^*}{P}\right)^{1-\alpha} I(r)$$

$$I_f = (1-\alpha)\Omega_0 \left(\frac{EP^*}{P}\right)^{-\alpha} I(r)$$

$$G_d = \alpha\Omega_0 \left(\frac{EP^*}{P}\right)^{1-\alpha} G$$

$$G_f = (1-\alpha)\Omega_0 \left(\frac{EP^*}{P}\right)^{-\alpha} G$$

Armington approach (4)

- Assume that export demand also depends on relative price (modelled later):

$$EX = EX_0 \left(\frac{EP^*}{P} \right)^{\beta}, \qquad \beta \geq 0$$

  - EX_0 is exogenous component of export demand (e.g. income in RoW, etcetera).
  - The higher is EP^*/P the cheaper are domestic goods for customers in RoW and the higher are exports.

Armington approach (5)

- Re-do national income accounting:

$$\begin{aligned} PY &\equiv P_C C + P_C I + P_C G + PEX - EP^* \left[C_f + I_f + G_f \right] \\ &= PC_d + PI_d + PG_d + PEX \quad \Rightarrow \\ Y &\equiv C_d + I_d + G_d + EX \end{aligned} \tag{S5}$$

  - Used in second line:

$$\begin{aligned} P_C C &= PC_d + EP^* C_f \\ P_C I &= PI_d + EP^* I_f \\ P_C G &= PG_d + EP^* G_f \end{aligned}$$

$\rightarrow$ (S5) shows quite clearly that only domestic goods enter GDP.

Self test

****** Self Test ******

The Armington approach is very popular in applied modelling. Here are some exercises.

- *Show the derivations leading to the expressions for* C_d, C_f, *and* P_C.
- *Assume composite consumption is a CES aggregate of* C_d *and* C_f. *Rederive the expressions for* C_d, C_f, *and* P_C *and interpret (difficult).*

****

Self test

****** Self Test ******

Define net exports in real terms as:

$$X \equiv EX - (EP^*/P)\left[C_f + I_f + G_f\right]$$

Derive the Marshall-Lerner condition and show how α and β affect it.

****

Extended Mundell-Fleming model (1)

- Perfect capital mobility.
- Flexible exchange rates.
- Fixed capital stock $\bar{K}$ (short-run model).
- Demand side goods market:

$$Y = \alpha\Omega_0 Q^{1-\alpha}\left[A(r,Y) + G\right] + EX_0 Q^{\beta}$$

  - $Q \equiv EP^*/P$ is the relative price of foreign goods. (Note that $Q \downarrow$ is real *appreciation* of domestic currency!)
  - $A(r,Y) \equiv C(Y) + I(r)$.

Extended Mundell-Fleming model (2)

- Supply side goods market:

$$
\begin{aligned}
W &= PF_N\left(N, \bar{K}\right) && \text{(S6)} \\
W &= W_0 P_C^{\lambda}, \qquad 0 \leq \lambda \leq 1 && \text{(S7)} \\
Y &= F\left(N, \bar{K}\right) && \text{(S8)}
\end{aligned}
$$

  - (S6) is short-run labour demand, wage equals value of MP of labour.
  - (S7) is a wage-setting rule (W_0 is exogenous). Special cases:
    - $\lambda = 1$ real wage target: hold W/P_C constant.
    - $\lambda = 0$ nominal wage target: hold W constant.
    - $0 < \lambda < 1$ incomplete wage indexing: changes in cost of living not fully incorporated in wage claims.

Extended Mundell-Fleming model (3)

- Money market equilibrium:

$$M/P = L(r, Y)$$

- Perfect capital mobility:

$$r = r^*$$

- The model can be analyzed.
  - Mathematically by loglinearizing it—see **Table 10.2** for the key expressions.
  - . . . Graphically by means of **Figure 10.8**.

Table 10.2: The extended Mundell-Fleming model

$$\tilde{Y} = \frac{(1-\omega_X)\left[-\omega_I \varepsilon_{IR} dr^* + (1-\omega_C-\omega_I)\tilde{G}\right] + \omega_X \widetilde{EX}_0}{1-(1-\omega_X)\omega_C \varepsilon_{CY}} \tag{T2.1}$$

$$+ \frac{\left[(1-\alpha)(1-\omega_X)+\beta\omega_X\right]\tilde{Q}}{1-(1-\omega_X)\omega_C \varepsilon_{CY}}$$

$$\tilde{M} - \tilde{P} = -\varepsilon_{MR} dr^* + \varepsilon_{MY} \tilde{Y} \tag{T2.2}$$

$$\tilde{Y} = -\varepsilon_{YW}\left[\tilde{W}_0 + \lambda(1-\alpha)\tilde{Q} - (1-\lambda)\tilde{P}\right] \tag{T2.3}$$

On the AS curve (1)

- See **Figure 10.8**.
- Labour demand downward sloping:

$$\tilde{N} = -\varepsilon_{NW} \cdot [\tilde{W} - \tilde{P}]$$

- Labour supply horizontal:

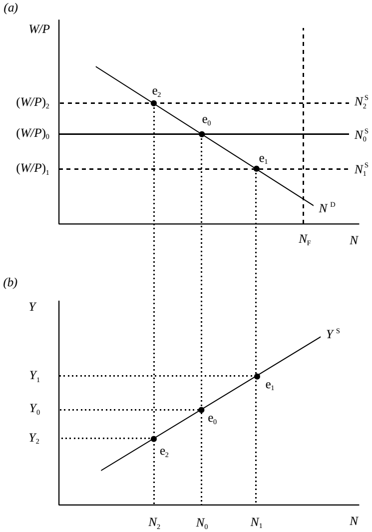
$$\begin{aligned}
\tilde{W} &= \tilde{W}_0 + \lambda \tilde{P}_C \\
&= \tilde{W}_0 + \lambda \cdot \left[\tilde{P} + (1-\alpha)\,\tilde{Q}\right] \\
\tilde{W} - \tilde{P} &= \tilde{W}_0 - (1-\lambda) \cdot \tilde{P} + \lambda\,(1-\alpha) \cdot \tilde{Q}
\end{aligned}$$

- Initial equilibrium at e_0

On the AS curve (2)

- Nominal wage rigidity case: $\lambda = 0$
  - no effect of real exchange rate
  - an increase (decrease) in P results in downward (upward) shift of labour supply and moves equilibrium to e_1 (to e_2), so that employment and output increase (decrease)
- Real wage rigidity case: $\lambda = 1$
  - no effect of price level
  - an decrease (increase) in Q results in downward (upward) shift of labour supply and moves equilibrium to e_1 (to e_2), so that employment and output increase (decrease)
- Money illusion: $0 < \lambda < 1$
  - AS depends positively on P
  - AS depends negatively on Q

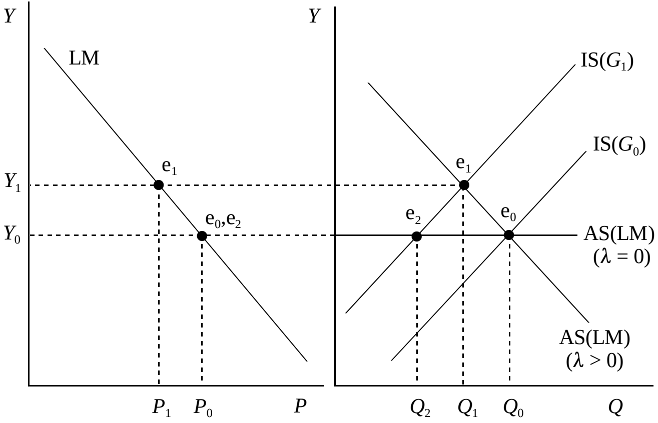
Figure 10.8: Aggregate supply curve for the open economy



Comparative static effects

- Interpretation of Table 10.2 & Figure 10.9:
  - $\tilde{Y} \equiv dY/Y$, $\tilde{P} \equiv dP/P$, $\tilde{Q} \equiv dQ/Q$ etcetera.
  - Endogenous: Y, P, and Q.
  - Exogenous: r^*, G, EX_0, W_0.
  - Eqn. (T2.1) is the IS curve for the open economy: negative effect on Y of r^*; positive effects of G, EX_0, and Q.
  - Equation (T2.2) is the LM curve with PCM substituted.
  - Equation (T2.3) is the AS curve: negative effects on Y of W_0 and Q (if $\lambda > 0$); positive effect of P (if $0 < \lambda < 1$). Why?

Figure 10.9: Aggregate demand shocks under wage rigidity



Fiscal policy (1)

- In Figure 10.9, AS(LM) is the combination of the LM curve and the AS curve:

$$\tilde{Y} = \frac{-\varepsilon_{YW}\left[\tilde{W}_0 + \lambda(1-\alpha)\tilde{Q} - (1-\lambda)\left(\tilde{M} + \varepsilon_{MR} dr^*\right)\right]}{1 + (1-\lambda)\varepsilon_{MY}\varepsilon_{YW}}$$

  - Horizontal in (Y, Q)-space if $\lambda = 0$ (NWR).
  - Downward sloping in (Y, Q)-space if $\lambda > 0$ (IWI or even RWR).
  - Independent of M and r^* if $\lambda = 1$ (RWR).

Fiscal policy (2)

- Increase in government consumption.
  - In standard MF model: no effect on N and Y (insulation property of flexible exchange rates).
  - In extended MF model: IS shifts up, from IS(G_0) to IS(G_1).
    - If $\lambda = 0$, Q appreciates (from Q_0 to Q_2) and P stays the same. No effect on N, P, and Y (insulation again).
    - If $\lambda > 0$, Q appreciates (from Q_0 to Q_1), P falls (from P_0 to P_1), W/P falls, N and Y increase.
- Conclusion: depending on wage-setting regime, the supply side can matter a lot! See **Table 10.3** for monetary and wage-setting shocks.

Table 10.3: Wage rigidity and demand and supply shocks

	$\omega_G(1-\omega_X)\tilde{G}$ $\omega_X\widetilde{EX}_0$	$\tilde{M}$	$\varepsilon_{YW}\tilde{W}_0$
$\tilde{Y}$	$\frac{\lambda(1-\alpha)\varepsilon_{YW}}{\lvert\Delta\rvert} \geq 0$	$\frac{(1-\lambda)\delta_1\varepsilon_{YW}}{\lvert\Delta\rvert} \geq 0$	$-\frac{\delta_1}{\lvert\Delta\rvert} < 0$
$\tilde{Q}$	$-\frac{1+(1-\lambda)\varepsilon_{MY}\varepsilon_{YW}}{\lvert\Delta\rvert} < 0$	$\frac{(1-\lambda)\delta_2\varepsilon_{YW}}{\lvert\Delta\rvert} \geq 0$	$-\frac{\delta_2}{\lvert\Delta\rvert} < 0$
$\tilde{P}$	$-\frac{\lambda(1-\alpha)\varepsilon_{MY}\varepsilon_{YW}}{\lvert\Delta\rvert} \leq 0$	$\frac{\lambda(1-\alpha)\delta_2\varepsilon_{YW}+\delta_1}{\lvert\Delta\rvert} > 0$	$\frac{\delta_1\varepsilon_{MY}}{\lvert\Delta\rvert} > 0$
$\tilde{E}$	$-\frac{1+(1-\alpha\lambda)\varepsilon_{MY}\varepsilon_{YW}}{\lvert\Delta\rvert} < 0$	$\frac{(1-\alpha\lambda)\delta_2\varepsilon_{YW}+\delta_1}{\lvert\Delta\rvert} > 0$	$\frac{\delta_1\varepsilon_{MY}-\delta_2}{\lvert\Delta\rvert} \gtrless 0$
$\tilde{P}_C$	$-\frac{(1-\alpha)(1+\varepsilon_{MY}\varepsilon_{YW})}{\lvert\Delta\rvert} < 0$	$\frac{(1-\alpha)\delta_2\varepsilon_{YW}+\delta_1}{\lvert\Delta\rvert} > 0$	$\frac{\delta_1\varepsilon_{MY}-(1-\alpha)\delta_2}{\lvert\Delta\rvert} \gtrless 0$

Shock transmission in a two-country world (1)

- Assumptions:
  - The world consists of two identical countries (symmetric case).
  - Perfect capital mobility.
  - World interest rate endogenous.
- Model modification: one country's exports are the other country's imports.
  - Imports by domestic economy (country 1):

$$EX^* \equiv C_f + I_f + G_f = (1-\alpha)\Omega_0 \left(\frac{EP^*}{P}\right)^{-\alpha} [A(r,Y) + G]$$

  - Imports by foreign economy (country 2) by symmetry:

$$EX \equiv C_f^* + I_f^* + G_f^* = (1-\alpha)\Omega_0 \left(\frac{EP^*}{P}\right)^{\alpha} [A(r^*,Y^*) + G^*]$$

where stars refer to foreign variables.

Shock transmission in a two-country world (2)

- Look at IS and IS* curves:

$$\begin{aligned} Y &= \alpha\Omega_0 Q^{1-\alpha}\left[A(r,Y)+G\right] \\ &\quad +(1-\alpha)\Omega_0\left(\frac{EP^*}{P}\right)^{\alpha}\left[A(r^*,Y^*)+G^*\right] \qquad \text{(S9)} \\ Y^* &= \alpha\Omega_0 Q^{-(1-\alpha)}\left[A(r^*,Y^*)+G^*\right] \\ &\quad +(1-\alpha)\Omega_0\left(\frac{EP^*}{P}\right)^{-\alpha}\left[A(r,Y)+G\right] \qquad \text{(S10)} \end{aligned}$$

  - Both own and foreign spending enters both IS curves.
  - Note sign of real exchange rate effects.
  - Since PCM implies $r = r^*$, (S9) and (S10) can be combined into quasi-reduced form expressions (details in text):

Shock transmission in a two-country world (3)

- Continued.

$$
\begin{aligned}
Y &= \Psi[\underset{-}{r^*}, \underset{++}{G}, \underset{+}{G^*}, \underset{+}{Q}] \\
Y^* &= \Phi[\underset{-}{r^*}, \underset{+}{G}, \underset{++}{G^*}, \underset{-}{Q}]
\end{aligned}
$$

  - Own fiscal policy effect greater than spillover effect (assumed).
  - Interest rate effect same in both countries (via investment).
  - Real exchange rate effect different sign (for obvious reasons).
- From here on we work with logarithmic version of the two-country model. See **Table 10.4**.

Table 10.4: A two-country extended Mundell-Fleming model

$$y = -\varepsilon_{YR} r^* + \varepsilon_{YQ} q + \varepsilon_{YG} [g + \eta g^*] \quad \text{(T3.1)}$$

$$y^* = -\varepsilon_{YR} r^* - \varepsilon_{YQ} q + \varepsilon_{YG} [g^* + \eta g] \quad \text{(T3.2)}$$

$$m - p = \varepsilon_{MY} y - \varepsilon_{MR} r^* \quad \text{(T3.3)}$$

$$m^* - p^* = \varepsilon_{MY} y^* - \varepsilon_{MR} r^* \quad \text{(T3.4)}$$

$$y = -\varepsilon_{YW} [w - p] \quad \text{(T3.5)}$$

$$y^* = -\varepsilon_{YW} [w^* - p^*] \quad \text{(T3.6)}$$

$$w = w_0 + \lambda p_C \quad \text{(T3.7)}$$

$$w^* = w_0^* + \lambda^* p_C^* \quad \text{(T3.8)}$$

$$p_C = \omega_0 + p + (1 - \alpha) q \quad \text{(T3.9)}$$

$$p_C^* = \omega_0 + p^* - (1 - \alpha) q \quad \text{(T3.10)}$$

Economic policy and the world economy

- To build intuition we first look at some symmetric cases:
  - Nominal wage rigidity (NWR) in both countries.
  - Real wage rigidity (RWR) in both countries.
- Next, we look at asymmetric case:
  - NWR in foreign country (say the United States).
  - RWR in domestic country (say Europe).

Nominal wage rigidity and economic policy (1)

- Assumptions: $\lambda = \lambda^* = 0$ in Table 10.4.
- Model can be summarized graphically **Figure 10.11**.
  - AS$_N$ and AS$_N^*$ curves are:

$$\begin{aligned} y &= -\varepsilon_{YW}\left[w_0 - p\right] && (\mathsf{AS}_N) \\ y^* &= -\varepsilon_{YW}\left[w_0^* - p^*\right] && (\mathsf{AS}_N^*) \end{aligned}$$

  - Combining with relevant LM curves gives:

$$y = \frac{\varepsilon_{YW}\left[m + \varepsilon_{MR} r^* - w_0\right]}{1 + \varepsilon_{YW}\varepsilon_{MY}} \qquad (\mathsf{LM}(\mathsf{AS}_N))$$

$$y^* = \frac{\varepsilon_{YW}\left[m^* + \varepsilon_{MR} r^* - w_0^*\right]}{1 + \varepsilon_{YW}\varepsilon_{MY}} \qquad (\mathsf{LM}^*(\mathsf{AS}_N^*))$$

Nominal wage rigidity and economic policy (2)

- Continued.
  - and:

$$
\begin{aligned}
p &= \frac{m + \varepsilon_{MR} r^* + \varepsilon_{YW} \varepsilon_{MY} w_0}{1 + \varepsilon_{YW} \varepsilon_{MY}} \\
p^* &= \frac{m^* + \varepsilon_{MR} r^* + \varepsilon_{YW} \varepsilon_{MW} w_0^*}{1 + \varepsilon_{YW} \varepsilon_{MY}}
\end{aligned}
$$

  - In view of symmetry assumptions ($m = m^*$and $w_0 = w_0^*$), LM*(AS$_N^*$) and LM(AS$_N$) coincide in Figure 10.11.

Nominal wage rigidity and economic policy (3)

- Continued.
  - Combining LM(AS$_N$) with IS and LM*(AS$_N^*$) with IS* yields:

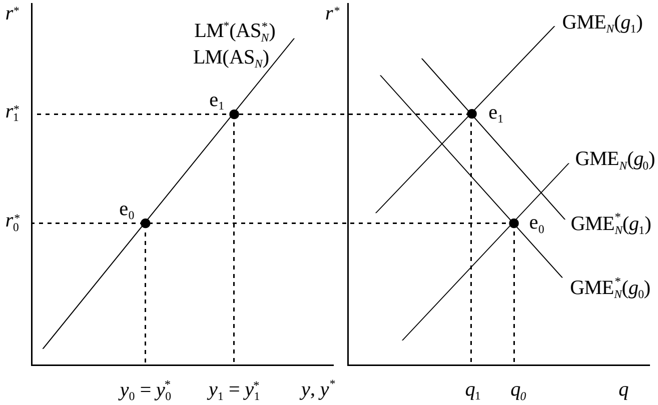
$$
\begin{aligned}
r^* &= \frac{(1+\varepsilon_{YW}\varepsilon_{MY})\left[\varepsilon_{YQ}q+\varepsilon_{YG}(g+\eta g^*)\right]}{\varepsilon_{YR}(1+\varepsilon_{YW}\varepsilon_{MY})+\varepsilon_{YW}\varepsilon_{MR}} \\
&\quad+\frac{\varepsilon_{YW}\left[w_0-m\right]}{\varepsilon_{YR}(1+\varepsilon_{YW}\varepsilon_{MY})+\varepsilon_{YW}\varepsilon_{MR}} \qquad (\text{GME}_N) \\
r^* &= \frac{(1+\varepsilon_{YW}\varepsilon_{MY})\left[-\varepsilon_{YQ}q+\varepsilon_{YG}(g^*+\eta g)\right]}{\varepsilon_{YR}(1+\varepsilon_{YW}\varepsilon_{MY})+\varepsilon_{YW}\varepsilon_{MR}} \\
&\quad+\frac{\varepsilon_{YW}\left[w_0^*-m^*\right]}{\varepsilon_{YR}(1+\varepsilon_{YW}\varepsilon_{MY})+\varepsilon_{YW}\varepsilon_{MR}} \qquad (\text{GME}_N^*)
\end{aligned}
$$

  - In Figure 10.11 these curves are drawn (notice slopes).

Nominal wage rigidity and economic policy (4)

- Fiscal policy in domestic economy (g up).
  - GME_N and GME_N^* shift up (former by more if $\eta < 1$ "dominant own effect").
  - Equilibrium from e_0 to e_1.
  - Real exchange rate domestic economy appreciates.
  - Output in both countries rises! **Locomotive policy**: one country drags itself and the other country out of a recession (real wages fall).
- Fiscal policy in foreign economy (g^* up): exercise.
  - r^* up; y and y^* up by same amount.
  - Used below: $\zeta = \zeta^* = 1$.

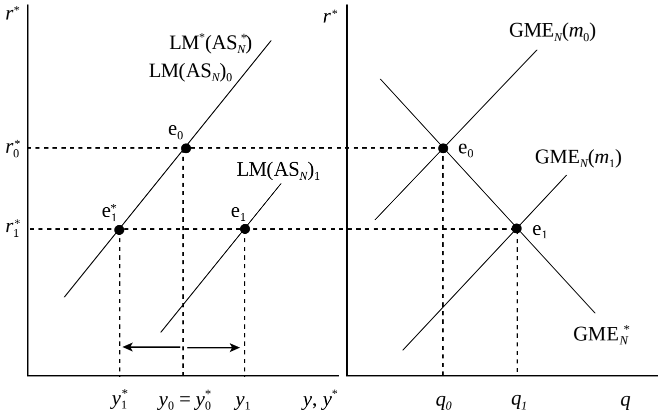
Figure 10.11: Fiscal policy with nominal wage rigidity in both countries



Nominal wage rigidity and economic policy (5)

- Monetary policy in domestic economy (m up).
  - See **Figure 10.12**.
  - GME_N goes down.
  - LM(AS_N) to the left.
  - Equilibrium from e_0 to e_1 in right-hand panel.
  - In left-hand panel, domestic economy from e_0 to e_1; foreign economy from e_0 to e_1^*.
  - Domestic economy gains at expense of foreign country: **beggar-thy-neighbour policy**.
- Monetary policy in foreign economy (m^* up): exercise.

Figure 10.12: Monetary policy with nominal wage rigidity in both countries



Real wage rigidity and economic policy (1)

- Assumptions: $\lambda = \lambda^* = 1$ in Table 10.4.
- Model can be summarized graphically **Figure 10.13**.
  - AS_R and AS_R^* curves are:

$$y = -\varepsilon_{YW}\left[\omega_0 + w_0 + (1-\alpha)q\right] \qquad (\text{AS}_R)$$

$$y^* = -\varepsilon_{YW}\left[\omega_0 + w_0^* - (1-\alpha)q\right] \qquad (\text{AS}_R^*)$$

  - Combining with relevant IS curves gives:

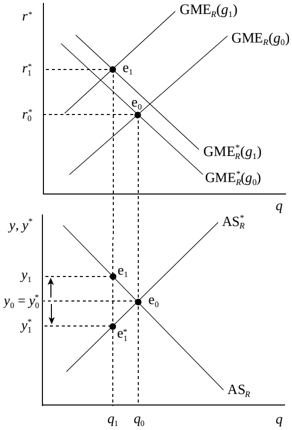
$$r^* = \frac{\varepsilon_{YW}\left[\omega_0 + w_0\right] + (\varepsilon_{YQ} + \varepsilon_{YW})q + \varepsilon_{YG}\left[g + \eta g^*\right]}{\varepsilon_{YR}} \qquad (\text{GME}_R)$$

$$r^* = \frac{\varepsilon_{YW}\left[\omega_0 + w_0^*\right] - (\varepsilon_{YQ} + \varepsilon_{YW})q + \varepsilon_{YG}\left[g^* + \eta g\right]}{\varepsilon_{YR}} \qquad (\text{GME}_R^*)$$

Real wage rigidity and economic policy (2)

- Fiscal policy in domestic economy (g up).
  - GME_R and GME_R^* shift up (former by more if $\eta < 1$ "dominant own effect").
  - Equilibrium from e_0 to e_1.
  - Real exchange rate domestic economy appreciates; interest rate rises.
  - Output rises in domestic economy but falls in foreign economy! **Beggar-thy-neighbour policy**: the domestic expansion hurts the other country (producer real wage falls domestically but rises abroad).
- Fiscal policy in foreign economy (g^* up): exercise.
  - y^* up, y down.
  - Used below: $\zeta = \zeta^* = -1$.
- Monetary policy has no real effects: exercise.

Figure 10.13: Fiscal policy with real wage rigidity in both countries



RWR-NWR* and economic policy (1)

- Mixed case studied by Branson & Rotemberg (1980):
  - RWR in domestic economy, say Europe ($\lambda = 1$):

$$y = -\varepsilon_{YW}\left[\omega_0 + w_0 + (1-\alpha)q\right] \qquad (\text{AS}_R)$$

$$r^* = \frac{\varepsilon_{YW}\left[\omega_0 + w_0\right] + (\varepsilon_{YQ} + \varepsilon_{YW})q + \varepsilon_{YG}\left[g + \eta g^*\right]}{\varepsilon_{YR}} \qquad (\text{GME}_R)$$

  - NWR in foreign economy, say the United States ($\lambda^* = 0$):

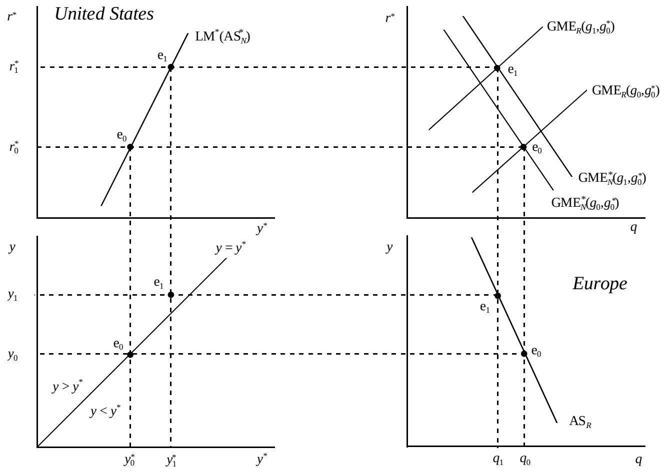
$$y^* = \frac{\varepsilon_{YW}\left[m^* + \varepsilon_{MR} r^* - w_0^*\right]}{1 + \varepsilon_{YW}\varepsilon_{MY}} \qquad (\text{LM}^*(\text{AS}_N^*))$$

$$r^* = \frac{(1 + \varepsilon_{YW}\varepsilon_{MY})\left[-\varepsilon_{YQ} q + \varepsilon_{YG}(g^* + \eta g)\right]}{\varepsilon_{YR}(1 + \varepsilon_{YW}\varepsilon_{MY}) + \varepsilon_{YW}\varepsilon_{MR}} + \frac{\varepsilon_{YW}\left[w_0^* - m^*\right]}{\varepsilon_{YR}(1 + \varepsilon_{YW}\varepsilon_{MY}) + \varepsilon_{YW}\varepsilon_{MR}} \qquad (\text{GME}_N^*)$$

RWR-NWR* and economic policy (2)

- Fiscal policy in domestic economy (g up): see **Figure 10.14**.
  - GME_R and GME_N^* shift up (former by more if $\eta < 1$ "dominant own effect").
  - Equilibrium from e_0 to e_1.
  - Real exchange rate domestic economy appreciates; interest rate rises.
  - Output rises in both economies. **Locomotive policy**: the domestic expansion benefits the other. country (producer real wage falls domestically but rises abroad).
  - Used below: $0 < \zeta^* < 1$.

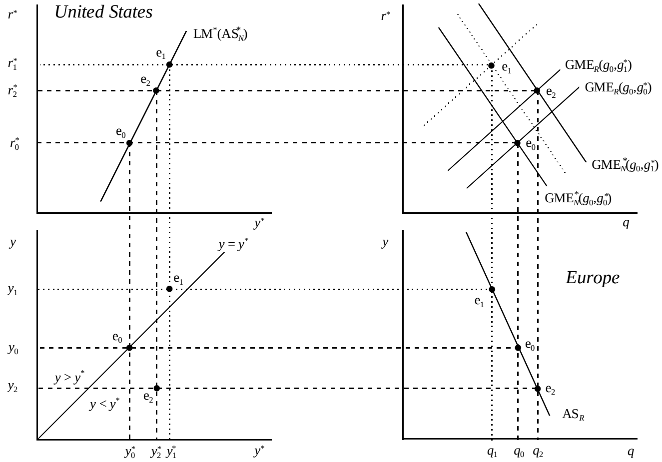
Figure 10.14: European fiscal policy with real wage rigidity in Europe and nominal wage rigidity in the United States



RWR-NWR* and economic policy (3)

- Fiscal policy in foreign economy (g^* up): see **Figure 10.15**.
  - GME$_R$ and GME$^*_N$ shift up (latter by more if $\eta < 1$ "dominant own effect").
  - Equilibrium from e$_0$ to e$_2$.
  - Real exchange rate domestic economy depreciates; interest rate rises.
  - Output falls in domestic economy but rises in the foreign economy! **Beggar-thy-neighbour policy**: the foreign expansion hurts the domestic economy (real wage rises domestically but falls abroad).
  - Used below: $\zeta < 0$.

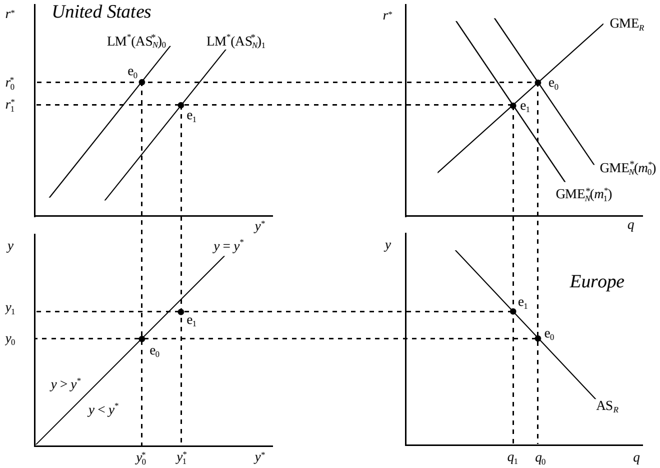
Figure 10.15: US fiscal policy with real wage rigidity in Europe and nominal wage rigidity in the United States



RWR-NWR* and economic policy (4)

- Monetary policy in domestic economy (m up) has no real effects.
- Monetary policy in foreign economy (m^* up): see **Figure 10.14**.
  - GME$^*_N$ down and LM*(AS$^*_N$) to the left.
  - Equilibrium from e$_0$ to e$_1$.
  - Real exchange rate domestic economy appreciates; interest rate falls.
  - Output rises in both economies (largest increase in domestic economy)! **Locomotive policy**: the foreign monetary expansion benefits the other country (producer real wage falls in both countries).

Figure 10.16: US monetary policy with real wage rigidity in Europe and nominal wage rigidity in the United States



International policy coordination (1)

- Policy question: is international coordination of policy welfare enhancing or not?
  - International spillovers.
  - Quantitative theory of economic policy (cf. Chapter 9).
- Summarize the insights from symmetric two-country model as follows:

$$y = g + \zeta g^* \tag{S11}$$

$$y^* = g^* + \zeta^* g \tag{S12}$$

  - g and g^* are indexes of fiscal policy.
  - NWR in both countries: $\zeta = \zeta^* = 1$.
  - RWR in both countries: $\zeta = \zeta^* = -1$.
  - RWR in home country, NWR in foreign country: $\zeta < 0$ and $0 < \zeta^* < 1$.

International policy coordination (2)

- Objective function domestic policy maker:

$$L_G \equiv \frac{1}{2}\left(y-\bar{y}\right)^2+\frac{\theta}{2}g^2 \qquad \text{(S13)}$$

  - L_G is the loss function (to be minimized s.t. trade-off (S11)).
  - $\bar{y}$ is the target output level.
  - Small government sector desired.

- Objective function foreign policy maker:

$$L_G^* \equiv \frac{1}{2}\left(y^*-\bar{y}\right)^2+\frac{\theta}{2}\left(g^*\right)^2 \qquad \text{(S14)}$$

  - L_G^* is the loss function (to be minimized s.t. trade-off (S12)).
  - $\bar{y}$ is the target output level (same as home country).
  - Small government sector desired.

Uncoordinated fiscal policy (1)

- Policy makers choose own fiscal policy, ignoring international spill-overs.
  - Domestic policy maker chooses g to minimize L_G subject to (S11). FONC:

$$\begin{aligned} \frac{\partial L_G}{\partial g} &= (g + \zeta g^* - \bar{y}) + \theta g = 0 \quad \Rightarrow \\ g &= \frac{\bar{y} - \zeta g^*}{1+\theta} \end{aligned} \tag{RR}$$

  - Foreign policy maker chooses g^* to minimize L_G^* subject to (S12). FONC:

$$\begin{aligned} \frac{\partial L_G^*}{\partial g^*} &= (g^* + \zeta^* g - \bar{y}) + \theta g^* = 0 \quad \Rightarrow \\ g^* &= \frac{\bar{y} - \zeta^* g}{1+\theta} \end{aligned} \tag{RR*}$$

Uncoordinated fiscal policy (2)

- Continued.
  - (RR) and (RR*) are so-called *reaction functions*: a country's best response, given what the other country does.
  - See **Figures 10.17-10.18** for the two pure cases. Non-cooperative Nash equilibrium is at the intersection of RR and RR*.
  - For symmetric case ($\zeta = \zeta^*$) we have:

$$g_N = g_N^* = \frac{\bar{y}}{1+\zeta+\theta} \qquad \text{(Symmetric)}$$

Uncoordinated fiscal policy (3)

- NWR in both countries: $\zeta = \zeta^* = 1$.
  - **Figure 10.17**: reaction functions downward sloping.
  - Unique non-cooperative Nash equilibrium at point N.
  - Stable: possible sequence is $g_0^* \to g_1 \to g_1^* \to g_2 \to \cdots\ g_{N-1}^* \to g_N$.
- RWR in both countries: $\zeta = \zeta^* < 0$.
  - **Figure 10.18**: reaction functions upward sloping
  - unique stable non-cooperative Nash equilibrium at point N.

Figure 10.17: International coordination of fiscal policy under nominalwage rigidity in both countries

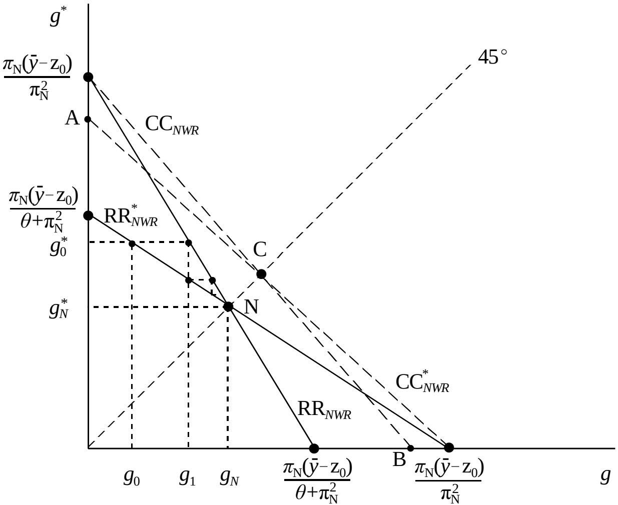
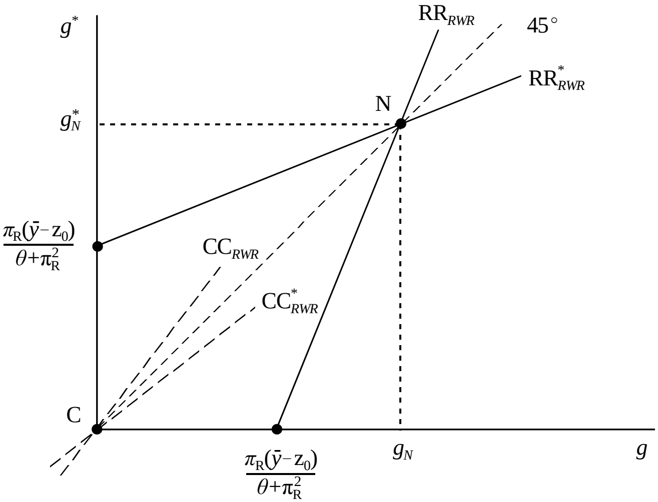


Figure 10.18: International coordination of fiscal policy under real wage rigidity in both countries



Coordinated fiscal policy (1)

- Is fiscal policy too expansionary?
- What would a coordinated fiscal policy look like?
- National policy makers give control over fiscal policy to international agency which sets g and g^* in order to minimize $L_G + L_G^*$ subject to the trade-offs (S11)–(S12).
  - Formally:

$$\min_{\{g^*,g\}} L_G + L_G^* \equiv \frac{1}{2}\left(g + \zeta g^* - \bar{y}\right)^2 + \frac{1}{2}\left(g^* + \zeta^* g - \bar{y}\right)^2 + \frac{\theta}{2} g^2 + \frac{\theta}{2}\left(g^*\right)^2$$

Coordinated fiscal policy (2)

- Continued.
  - FONCs:

$$\frac{\partial(L_G + L_G^*)}{\partial g} = (g + \zeta g^* - \bar{y}) + \zeta^* (g^* + \zeta^* g - \bar{y}) + \theta g = 0$$

$$\frac{\partial(L_G + L_G^*)}{\partial g^*} = \zeta (g + \zeta g^* - \bar{y}) + (g^* + \zeta^* g - \bar{y}) + \theta g^* = 0$$

  - Rewritten FONCs:

$$g = \frac{(1+\zeta^*)\,\bar{y} - (\zeta + \zeta^*)\,g^*}{1 + \theta + (\zeta^*)^2} \qquad \text{(CC)}$$

$$g^* = \frac{(1+\zeta)\,\bar{y} - (\zeta + \zeta^*)\,g}{1 + \theta + \zeta^2} \qquad \text{(CC}^*\text{)}$$

  - Symmetric solution:

$$g_C = g_C^* = \frac{\bar{y}}{1 + \zeta + \frac{\theta}{1+\zeta}} \qquad \text{(symmetric)}$$

Coordinated fiscal policy (3)

- By comparing (g_C, g_C^*) to (g_N, g_N^*) we can answer the question posed.
- NWR in both countries: $\zeta = \zeta^* = 1$.
  - $g_N < g_C$ and $g_N^* < g_C^*$ (see Figure 10.17).
  - Too little spending in non-cooperative equilibrium.
  - Fiscal policy is a locomotive policy; positive spill-over effect only taken into account in coordinated policy.
- RWR in both countries: $\zeta = \zeta^* = -1$.
  - $g_N > g_C$ and $g_N^* > g_C^*$ (see Figure 10.18).
  - Too much spending in non-cooperative equilibrium.
  - Fiscal policy is a beggar-thy-neighbour policy; negative spill-over effect only taken into account in coordinated policy.

Coordinated fiscal policy (4)

- RWR in Europe / NWR in United States.
  - Non-symmetric case.
  - $\zeta < 0$, $0 < \zeta^* < 1$.
  - (RR), (RR*), and FOCs unchanged. See **Figure D** (not in book).
  - Non-cooperative Nash equilibrium:

$$g_N = \frac{(1+\theta-\zeta)\bar{y}}{(1+\theta)^2-\zeta\zeta^*} = \frac{\bar{y}}{1+\zeta+\theta+\left[\frac{\zeta(\zeta-\zeta^*)}{1+\theta-\zeta}\right]}$$

$$g_N^* = \frac{(1+\theta-\zeta^*)\bar{y}}{(1+\theta)^2-\zeta\zeta^*} = \frac{\bar{y}}{1+\zeta+\theta-\left[\frac{(1+\theta)(\zeta-\zeta^*)}{1+\theta-\zeta}\right]}$$

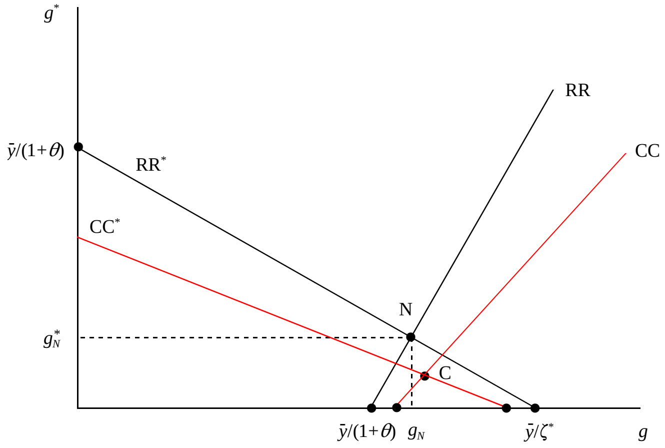
Coordinated fiscal policy (5)

- Continued.
  - comparison:

$$
\begin{aligned}
g_C &> g_N \\
g_C^* &< g_N^*
\end{aligned}
$$

  - Intuition:
    - In absence of coordination, Europe spends too little (locomotive) and the US spends too much (beggar-thy-neighbour).
    - Interest rate too high, dollar too strong, unemployment in Europe too high (conclusion not relevant in 2005 but was deemed relevant in early 1980s).

Figure D: Asymmetric case (RWR, NWR*)



Forward-looking behaviour in international financial markets

- Look at yields on two types of portfolio investment:

$$\begin{aligned} \text{yield gap} &\equiv (1+r) - (1+r^*)\frac{E_1^e}{E_0} = (1+r) - (1+r^*)\left(1+\frac{\Delta E^e}{E_0}\right) \\ &= (1+r) - \left(1 + r^* + \frac{\Delta E^e}{E_0} + r^*\frac{\Delta E^e}{E_0}\right) \\ &\approx r - \left(r^* + \frac{\Delta E^e}{E_0}\right) \qquad \text{(YG)} \end{aligned}$$

  - r is yield on domestic bonds (denominated, say, in Euros).
  - r^* is yield on foreign bonds (denominated, say, in US dollars).
  - E is the (spot) exchange rate (Euros per US dollar).
- In continuous time we can write (YG) as:

$$\text{yield gap} = r - (r^* + \dot{e}^e)$$

where $e \equiv \ln E$, and $\dot{e}^e \equiv de^e/dt \equiv \dot{E}^e/E$.

Forward-looking behaviour in international financial markets

- Arbitrage in world financial markets will ensure that like assets will earn like yields, i.e. uncovered interest parity holds:

$$r = r^* + \dot{e}^e \tag{UIP}$$

- Under flexible exchange rates the agents must form an expectation regarding future exchange rates:
  - So far we have used the assumption of inelastic expectations:

$$\dot{e}^e = 0 \tag{SEH}$$

  - From here on we will use the perfect foresight hypothesis:

$$\dot{e}^e = \dot{e} \tag{PFH}$$

- Rudiger Dornbusch (1942-2002) added (UIP) and (PFH) to the IS-LM model and investigated the effects of monetary and fiscal policy.

The Dornbusch model (1)

- Table 10.5 describes the Dornbush model. Key features:
  - All variables (except r and r^*) measured in logarithms.
    - Endogenous: y, r, e, and p.
    - Exogenous: p^*, g, m, and $\bar{y}$.
  - UIP and PFH assumed.
  - Prices are sticky.
  - Foreign and domestic goods imperfect substitutes.
- The phase diagram for the model is given in Figure 10.19.

Table 10.5: The Dornbusch model

$$
\begin{aligned}
y &= -\varepsilon_{YR} r + \varepsilon_{YQ} \left[p^* + e - p \right] + \varepsilon_{YG} g && \text{(T5.1)} \\
m - p &= -\varepsilon_{MR} r + \varepsilon_{MY} y && \text{(T5.2)} \\
r &= r^* + \dot{e}^e && \text{(T5.3)} \\
\dot{p} &= \phi \left[y - \bar{y} \right] && \text{(T5.4)} \\
\dot{e}^e &= \dot{e} && \text{(T5.5)}
\end{aligned}
$$

The Dornbusch model (2)

- Derivation
  - Quasi-reduced form expressions for r and y:

$$y = \frac{\varepsilon_{MR}\varepsilon_{YQ}\left[p^* + e - p\right] + \varepsilon_{MR}\varepsilon_{YG}g + \varepsilon_{YR}(m-p)}{\varepsilon_{MR} + \varepsilon_{MY}\varepsilon_{YR}} \quad \text{(S15)}$$

$$r = \frac{\varepsilon_{MY}\varepsilon_{YQ}\left[p^* + e - p\right] + \varepsilon_{MY}\varepsilon_{YG}g - (m-p)}{\varepsilon_{MR} + \varepsilon_{MY}\varepsilon_{YR}} \quad \text{(S16)}$$

  - Derive dynamic system for e and p:

$$\begin{bmatrix} \dot{e} \\ \dot{p} \end{bmatrix} = \begin{bmatrix} \frac{\varepsilon_{MY}\varepsilon_{YQ}}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} & \frac{1-\varepsilon_{MY}\varepsilon_{YQ}}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} \\ \frac{\phi\varepsilon_{MR}\varepsilon_{YQ}}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} & -\frac{\phi(\varepsilon_{YR}+\varepsilon_{MR}\varepsilon_{YQ})}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} \end{bmatrix} \begin{bmatrix} e \\ p \end{bmatrix} + \begin{bmatrix} \frac{\varepsilon_{MY}\varepsilon_{YQ}p^*+\varepsilon_{MY}\varepsilon_{YG}g-m}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} - r^* \\ \frac{\phi[\varepsilon_{MR}\varepsilon_{YQ}p^*+\varepsilon_{MR}\varepsilon_{YG}g+\varepsilon_{YR}m]}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} - \phi\bar{y} \end{bmatrix} \quad \text{(S17)}$$

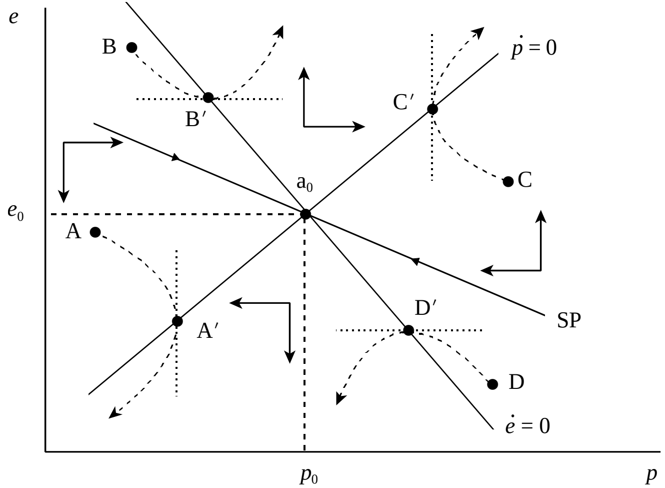
The Dornbusch model (3)

- Continued.
  - Draw equilibrium loci $\dot{e} = 0$ and $\dot{p} = 0$.

$$
\begin{aligned}
e + p^* &= \frac{-(1 - \varepsilon_{MY}\varepsilon_{YQ})p - \varepsilon_{MY}\varepsilon_{YG}g}{\varepsilon_{MY}\varepsilon_{YQ}} \\
&\quad + \frac{m + (\varepsilon_{MR} + \varepsilon_{MY}\varepsilon_{YR})r^*}{\varepsilon_{MY}\varepsilon_{YQ}} \qquad \text{(Edot)} \\
e + p^* &= \frac{(\varepsilon_{YR} + \varepsilon_{MR}\varepsilon_{YQ})p - \varepsilon_{MR}\varepsilon_{YG}g}{\varepsilon_{MR}\varepsilon_{YQ}} \\
&\quad + \frac{-\varepsilon_{YR}m + (\varepsilon_{MR} + \varepsilon_{MY}\varepsilon_{YR})\bar{y}}{\varepsilon_{MR}\varepsilon_{YQ}} \qquad \text{(Pdot)}
\end{aligned}
$$

  - Derive disequilibrium dynamics.
  - Verify that the unique equilibrium is a saddle point: e is a non-predetermined (jumping) variable; p is a predetermined (sticky) variable.

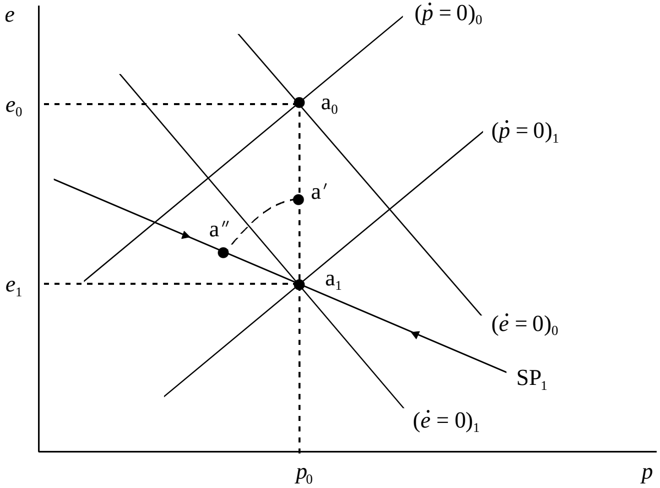
Figure 10.19: Phase diagram for the Dornbusch model



Economic policy in the Dornbusch model (1)

- Under PFH timing of policy is crucial (as in perfect foresight models of Chapter 4).
- Fiscal policy: unanticipated / permanent increase in g.
  - See **Figure 10.20**
  - $\dot{e} = 0$ and $\dot{p} = 0$ shift down.
  - Equilibrium from a_0 to a_1; immediate appreciation of currency.
  - No price change and no transitional dynamics.
  - Conclusion same as standard Mundell-Fleming model.
- Fiscal policy: anticipated / permanent increase in g.
  - Heuristic solution principle of Chapter 4.
  - Adjustment path jump from a_0 to a', gradual move from a' to a'' and then to a_1.
  - Intuition: self-test.

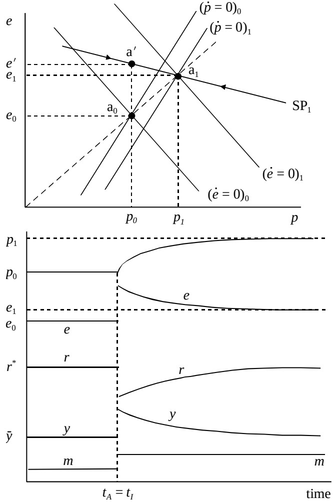
Figure 10.20: Fiscal policy in the Dornbusch model



Economic policy in the Dornbusch model (2)

- Monetary policy: unanticipated / permanent increase in m.
  - See **Figure 10.21**.
  - $\dot{e} = 0$ and $\dot{p} = 0$ to the right.
  - Long-run equilibrium from a$_0$ to a$_1$ (real exchange rate unaffected in long run).
  - Transitional dynamics: impact jump from a$_0$ to a$'$; thereafter gradual move from a$'$ to a$_1$.
  - Conclusion: the nominal exchange rate *overshoots* its long-run value in the short run! Intuition for overshooting:
    - Agents expect long-run depreciation of currency (e from e_0 to e_1).
    - Domestic assets less attractive, at impact $r \downarrow$ (net capital outflow) and $e \uparrow$.
    - During transition investors must be compensated for $r < r^*$ by appreciating exchange rate ($\dot{e} < 0$).
- Monetary policy: anticipated / permanent increase in m: self-test.

Figure 10.21: Monetary policy in the Dornbusch model



Overshooting: sensitivity analysis (1)

- What are the key assumptions leading to the overshooting result?
  - Role of price stickiness?
  - Role of imperfect capital mobility?
  - Role of monetary accommodation?
- Perfectly flexible prices in the Dornbush model.
  - $\phi \to \infty$, so $y = \bar{y}$ always.
  - Domestic interest rate:

$$r = \frac{(\varepsilon_{YQ}\varepsilon_{MY} - 1)\bar{y} + \varepsilon_{YQ}(p^* + e) + \varepsilon_{YG}g - \varepsilon_{YQ}m}{\varepsilon_{YR} + \varepsilon_{YQ}\varepsilon_{MR}}$$

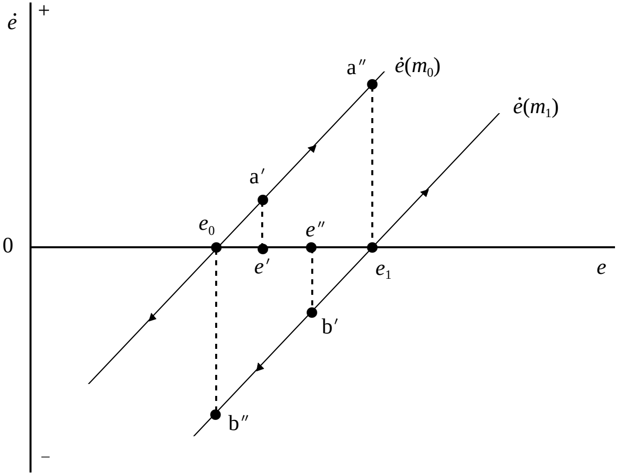
Overshooting: sensitivity analysis (2)

- Continued.
  - (Unstable) differential equation for e:

$$\dot{e} = \frac{(\varepsilon_{YQ}\varepsilon_M - 1)\bar{y} + \varepsilon_{YQ}(p^* + e) + \varepsilon_{YG}g - \varepsilon_{YQ}m}{\varepsilon_{YR} + \varepsilon_{YQ}\varepsilon_{MR}} - r^*$$

  - Unanticipated / permanent increase in m results in a once-off increase in e (depreciation): no overshooting!
  - See **Figure 10.22**.

Figure 10.22: Exchange rate dynamics with perfectly flexible prices



Overshooting: sensitivity analysis (3)

- Imperfect Capital Mobility in the Dornbusch model.
  - Frenkel & Rodriguez (1982).
  - Model given in **Table 10.6**.
  - Phase diagram with low capital mobility in **Figure 10.23**: no overshooting.
  - Phase diagram with high capital mobility in **Figure 10.24**: overshooting.
  - Lesson: sticky prices necessary but not sufficient condition for overshooting result to occur.

Table 10.6: The Frenkel-Rodriquez model

$$y^d = \bar{y} + \varepsilon_{DQ}\left[p^* + e - p\right] \quad \text{(T6.1)}$$

$$r = \varepsilon_{RY}\bar{y} - \varepsilon_{RM}\left[m - p\right] \quad \text{(T6.2)}$$

$$\dot{p} = \phi\left[y^d - \bar{y}\right] \quad \text{(T6.3)}$$

$$X = \varepsilon_{XQ}\left[p^* + e - p\right] \quad \text{(T6.4)}$$

$$KI = \xi\left[r - (r^* + \dot{e})\right] \quad \text{(T6.5)}$$

$$KI + X = 0 \quad \text{(T6.6)}$$

Figure 10.23: Exchange rate dynamics with low capital mobility

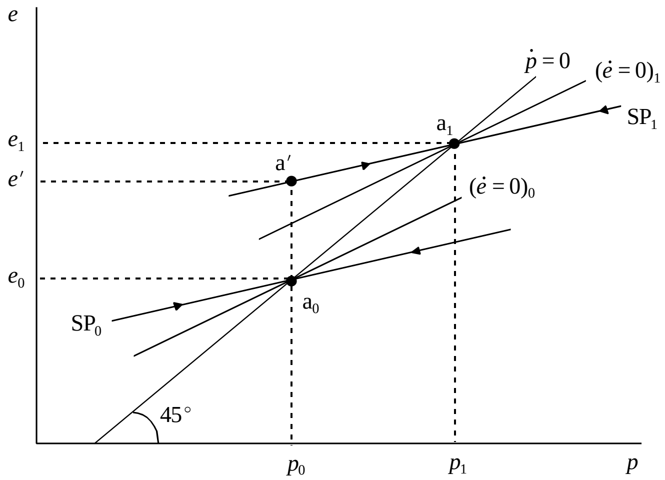
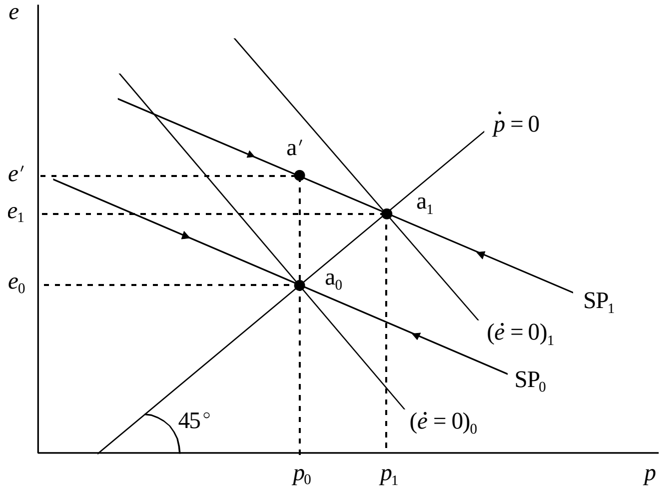


Figure 20.24: Exchange rate dynamics with high capital mobility



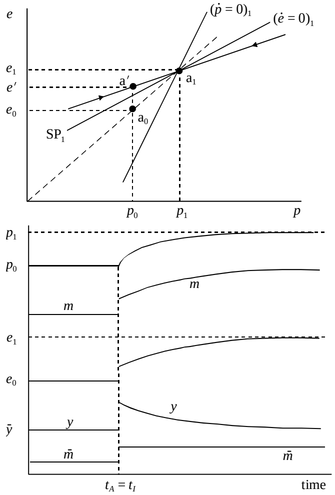
Overshooting: sensitivity analysis (4)

- Monetary accommodation in the Dornbusch model.
  - Policy maker may accommodate price shocks:

$$m = \bar{m} + \delta p$$

    - $\delta = 0$ in Dornbush model ("pure float" of the exchange rate).
    - $0 < \delta < 1$ here ("dirty float").
  - Phase diagram with no accommodation in Figure 10.21: overshooting.
  - Phase diagram with strong accommodation (δ high) in **Figure 10.25**: no overshooting.
  - Lesson: by engaging in monetary accommodation, the policy maker can prevent overshooting to occur.

Figure 10.25: Monetary accommodation and undershooting



Punchlines

- Crucial aspects open economy:
  - Financial openness.
  - Type of exchange rate system.
- Effects of fiscal and monetary policy depend on both aspects.
- From the supply side another aspect is highlighted: the wage setting rule.
- In a two-country setting, shocks generally spill over across countries.
- Coordinated policy is generally different from uncoordinated policy.
  - Direction of change depends on wage setting rule in place.
  - (Positive or negative) spill-overs internalized.

Punchlines

- Forward-looking sticky-price model with perfect capital mobility.
    - Overshooting: financial shocks cause volatility.
    - Determinants of overshooting.