Foundations of Modern Macroeconomics

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Chapter 11: The Open Economy

Aims of this lecture

- opening up the IS-LM model (sequel to material from Chapter 1): 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

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

$$Y \equiv C + I + G + (EX - IM) \qquad \text{(A)}$$

  - 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

- 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 (A) to get:

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

  - item (a): disposable income of residents
  - item (b): current account CA (of the BoP)

- Private sector saving:

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

- Combining (B) and (C):

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

  – 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):

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

- 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

- 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:

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

- Expression (D) 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

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

$$Y = A(\underset{-}{r}, \underset{+}{Y}) + G + X(\underset{-}{Y}, \underset{+}{Q}),$$

$$Q \equiv \frac{EP^*}{P}$$

  - $A(r, Y)$ 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$)
    - P is domestic price level (dimension Euro's)
    - P^* is foreign price level (dimension US$)

- 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

- 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: if $KI > 0$ then domestic agents sell more assets to RoW than RoW is buying from us; net borrowing from RoW.
  - r^* is interest rate in RoW

- 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 11.1**.

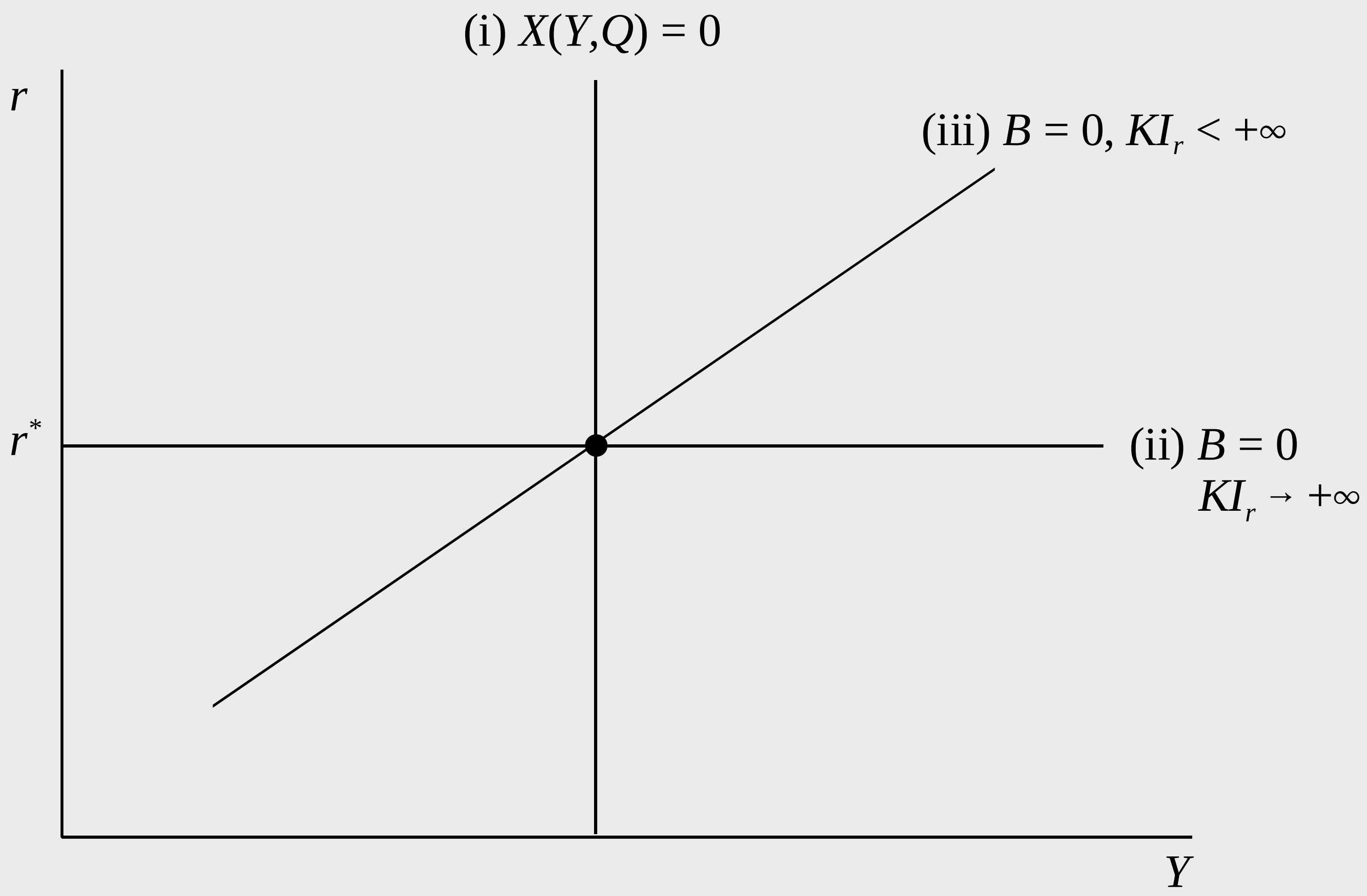

Figure 11.1: The Degree of Capital Mobility and the Balance of Payments

Immobile Capital and Fixed Exchange Rates

- Assumptions:
  - capital immobile: $KI(r - r^*) \equiv 0$
  - monetary authority maintains exchange rate at E_0
- Case is drawn in **Figure 11.2**.
  - IS downward sloping, LM upward sloping, $X(Y, E_0) = 0$ line vertical
  - to right (left) of $X(Y, E_0) = 0$ imports too high (low) and $B = X < 0$ (> 0)
  - initial equilibrium at point e_0

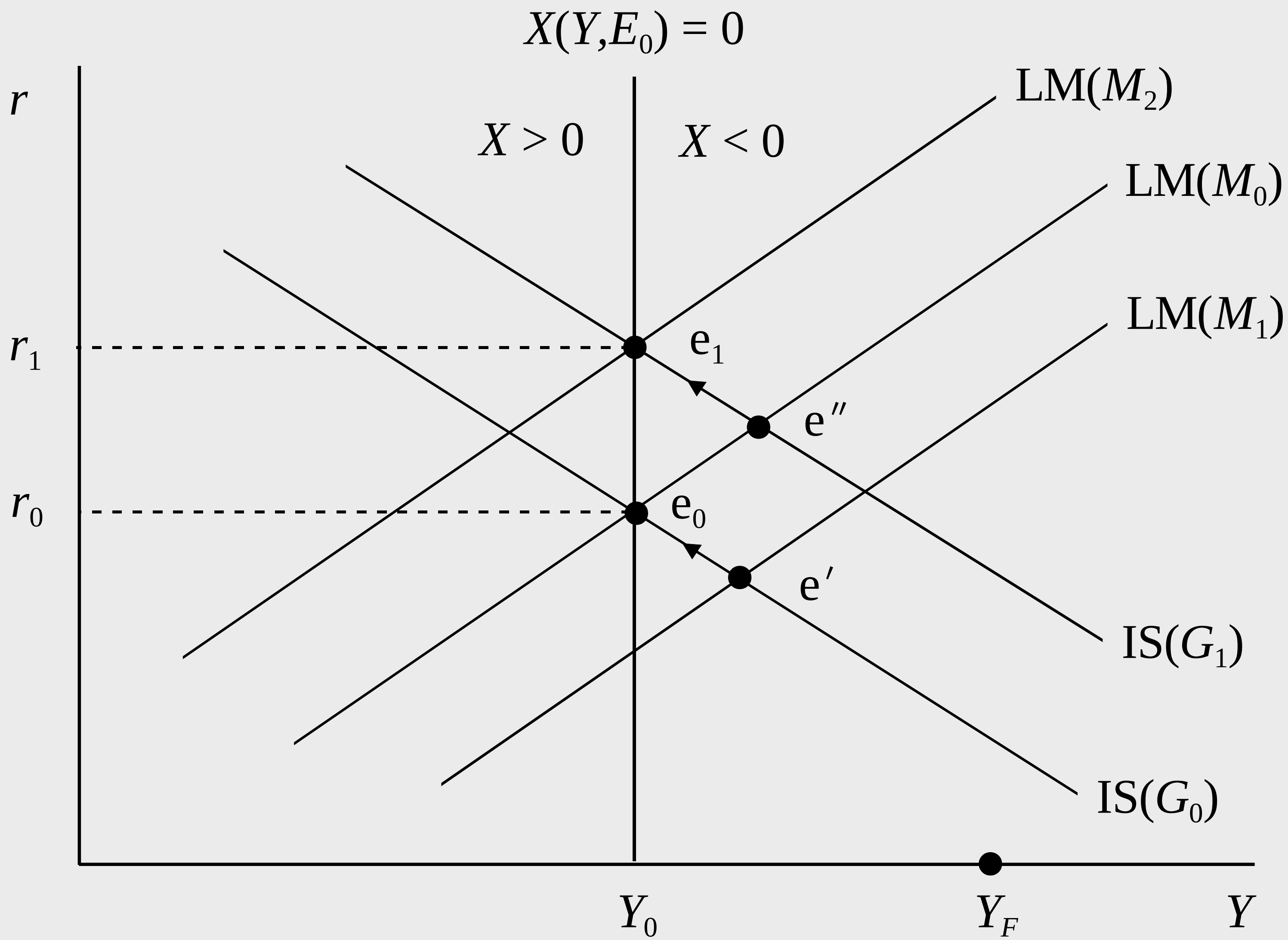

Figure 11.2: Monetary and Fiscal Policy with Immobile Capital and Fixed Exchange Rates

- 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

- 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

- Assumptions:
  - capital perfectly mobile: $r = r^*$
  - monetary authority maintains exchange rate at E_0
  - BP curve is horizontal in **Figure 11.3**
  - 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

- 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

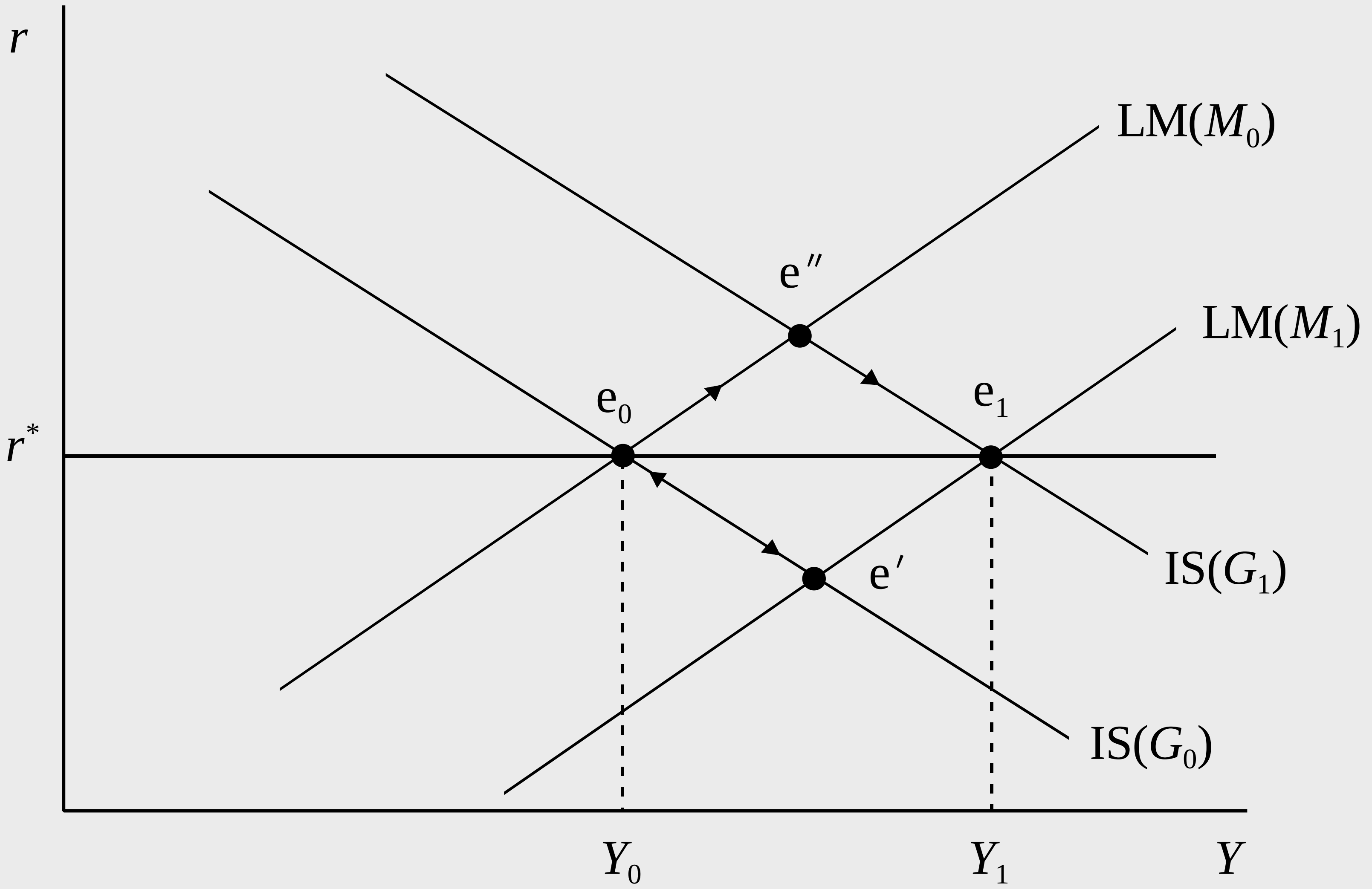

Figure 11.3: Monetary and Fiscal Policy with PCM and Fixed Exchange Rates

Perfect Capital Mobility and Flexible Exchange Rates

- 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)

- 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 11.4**
  - 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!

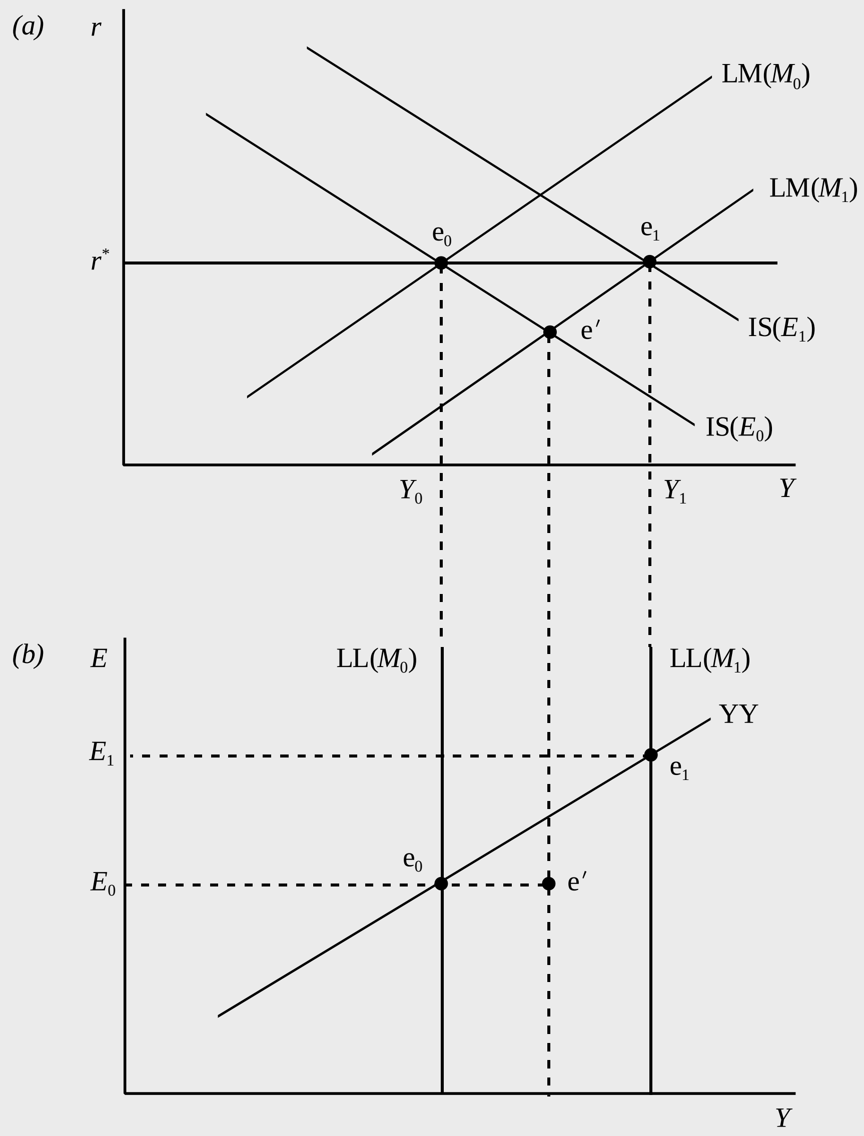

Figure 11.4: Monetary Policy with Perfect Capital Mobility and Flexible Exchange Rates

- Fiscal Policy
  - See **Figure 11.5**
  - 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: economy stays at e_0
  - fiscal policy completely ineffective!

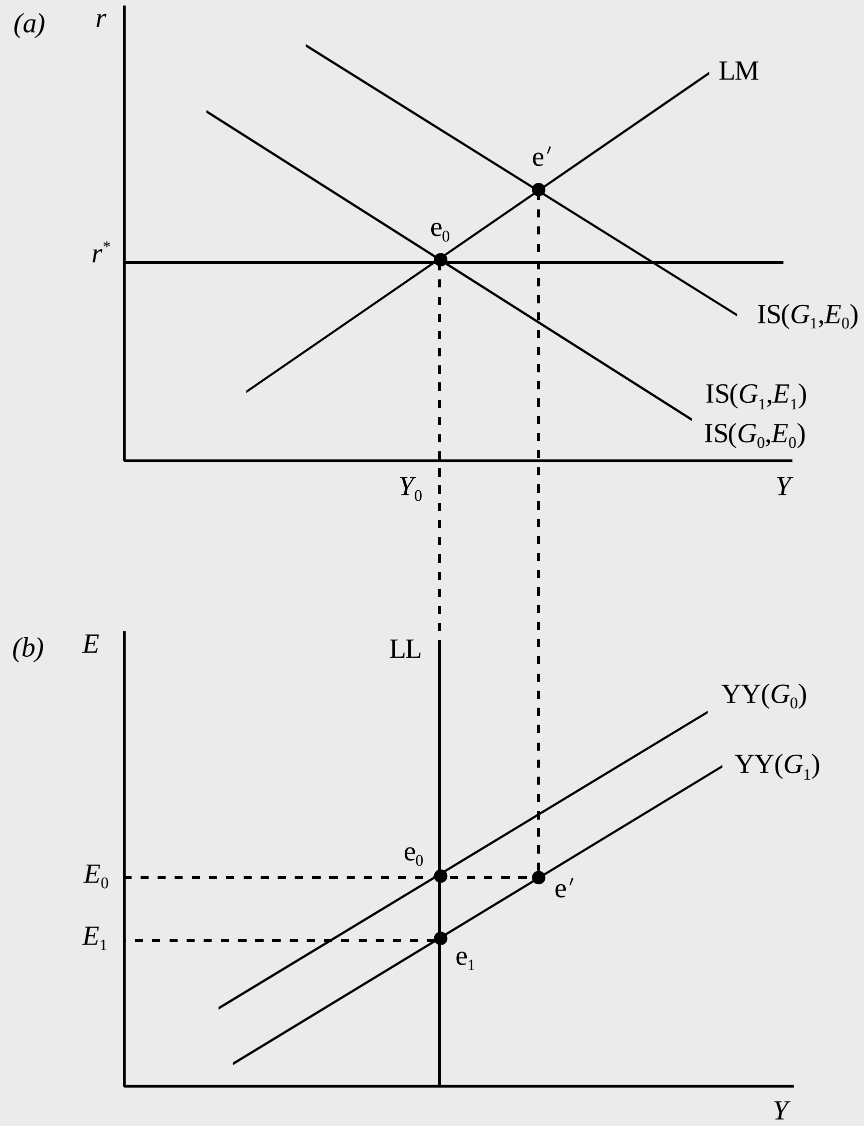

Figure 11.5: Fiscal Policy with Perfect Capital Mobility and Flexible Exchange Rates

- 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 11.6**
  - LL to right; YY up; domestic currency appreciates; output increases

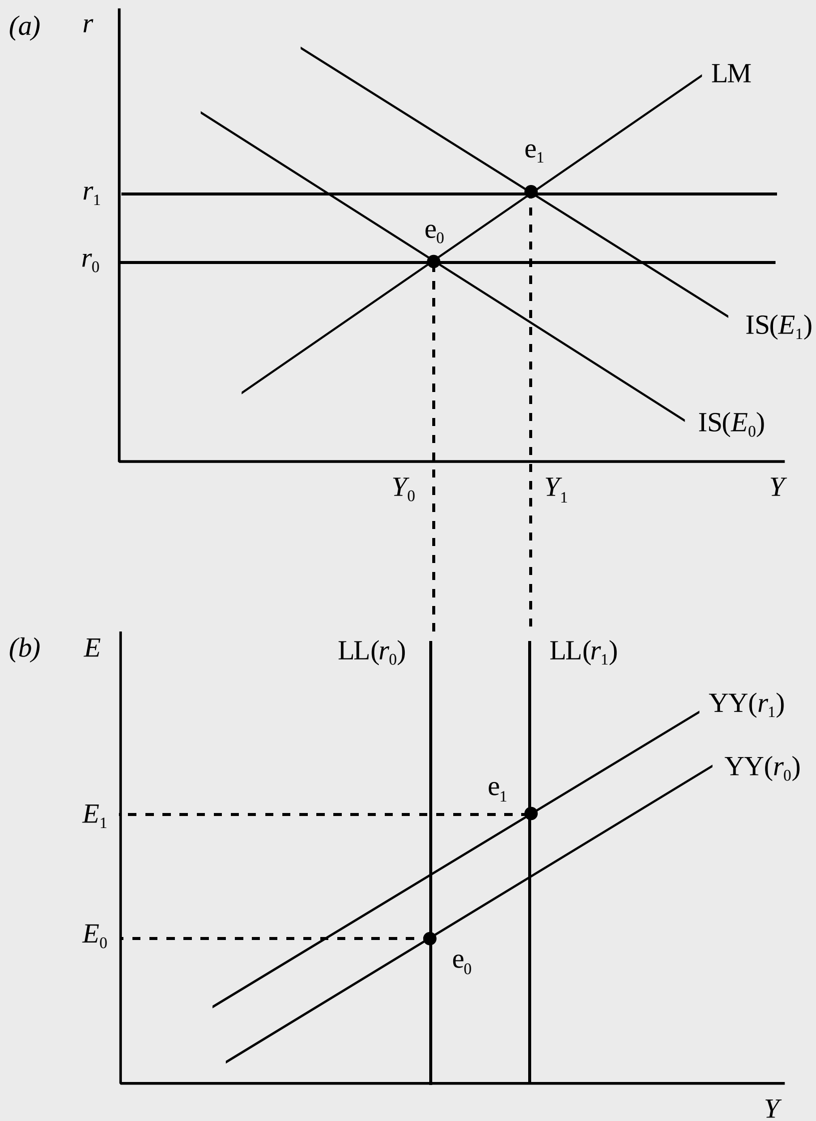

Figure 11.6: World Interest Rate Shock with PCM and Flexible Exchange Rates

Summary on 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 11.7** and **Table 11.1**)

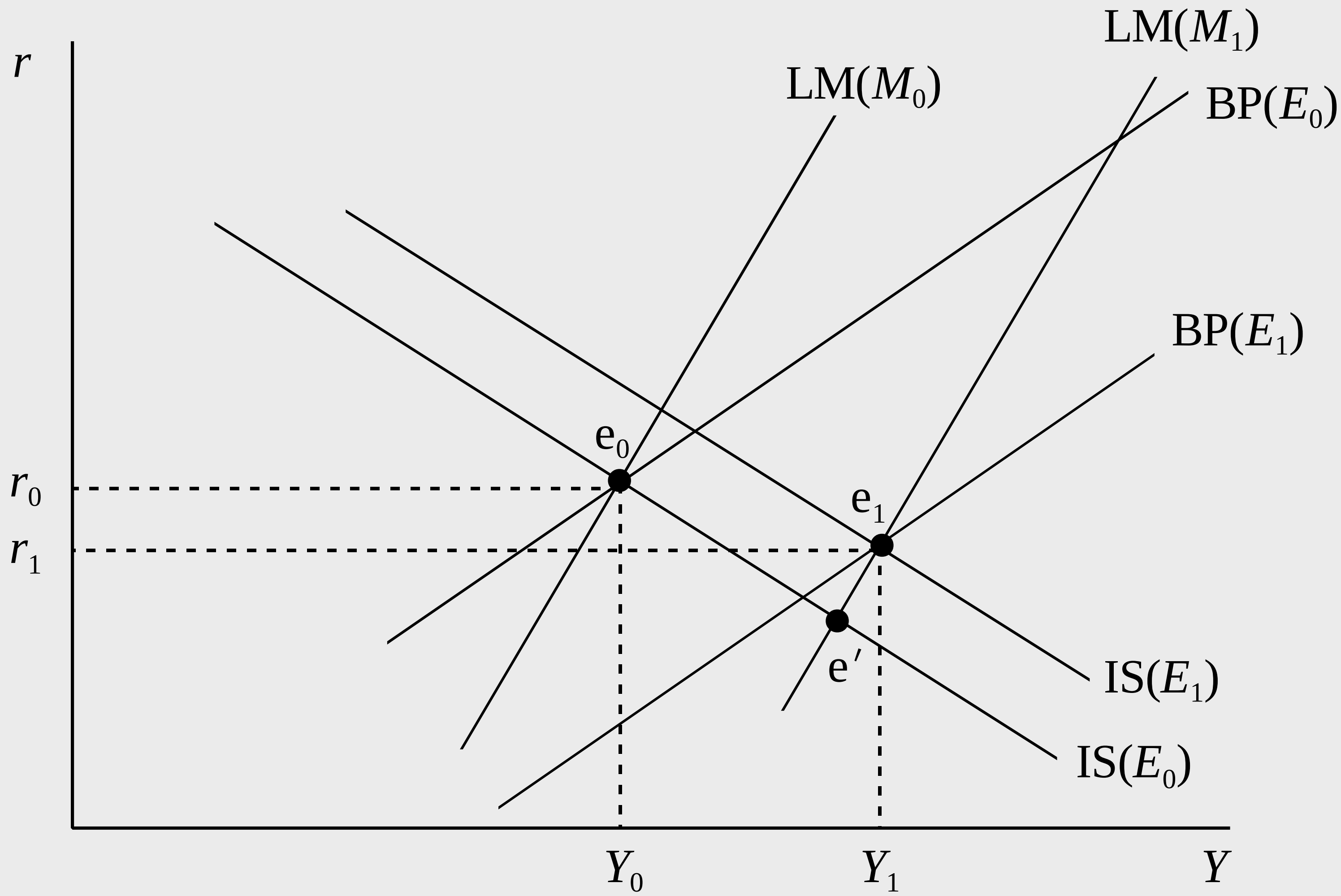

Figure 11.7: Monetary Policy with Imperfect Capital Mobility and Flexible Exchange Rates

Table 11.1. Capital Mobility and Comparative Static Effects

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

Table 11.1. Capital Mobility and Comparative Static Effects (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

- Macroeconomic relations:

$$C = C(Y)$$
$$I = I(r)$$

  - 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)

- choose C_d and C_f to minimize expenditure for given level of C
- solutions:

$$C_d = \alpha\Omega_0 \left(\frac{EP^*}{P}\right)^{1-\alpha} C(Y)$$

$$C_f = (1-\alpha)\Omega_0 \left(\frac{EP^*}{P}\right)^{-\alpha} C(Y)$$

$$P_C \equiv \Omega_0 P^\alpha \left(EP^*\right)^{1-\alpha}$$

where $\Omega_0 \equiv \left[\alpha^\alpha (1-\alpha)^{1-\alpha}\right]^{-1} > 0$

- 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

- 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:

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

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

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

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

- 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

- Re-do national income accounting:

$$PY \equiv P_C C + P_C I + P_C G + PEX - EP^* \left[C_f + I_f + G_f\right]$$
$$= PC_d + PI_d + PG_d + PEX \quad \Rightarrow$$
$$Y \equiv C_d + I_d + G_d + EX \qquad \text{(A)}$$

  – used in second line:

$$P_C C = PC_d + EP^* C_f$$
$$P_C I = PI_d + EP^* I_f$$
$$P_C G = PG_d + EP^* G_f$$

$\longrightarrow$ (A) shows quite clearly that only domestic goods enter GDP.

**** 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
- (difficult) 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

****

**** 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

- 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!]
  - $A(r, Y) \equiv C(Y) + I(r)$

- Supply side goods market:

$$W = PF_N\left(N, \bar{K}\right) \quad \text{(A)}$$

$$W = W_0 P_C^{\lambda}, \qquad 0 \leq \lambda \leq 1 \quad \text{(B)}$$

$$Y = F\left(N, \bar{K}\right) \quad \text{(C)}$$

  – (A) is short-run labour demand, wage equals value of MP of labour
  – (B) 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

- Money market equilibrium:

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

- Perfect capital mobility:

$$r = r^*$$

- The model can be analyzed
  - ...mathematically by log-linearizing it—see **Table 11.2** for the key expressions.
  - ...graphically by means of **Figure 11.8**.

Table 11.2. The Extended Mundell-Fleming Model

$$\tilde{Y} = \frac{(1-\omega_X)\left[-\omega_I \epsilon_{IR} dr^* + (1-\omega_C-\omega_I)\tilde{G}\right] + \omega_X \widetilde{EX}_0}{1-(1-\omega_X)\omega_C \epsilon_{CY}} + \frac{\left[(1-\alpha)(1-\omega_X)+\beta\omega_X\right]\tilde{Q}}{1-(1-\omega_X)\omega_C \epsilon_{CY}} \quad \text{(T2.1)}$$

$$\tilde{M} - \tilde{P} = -\epsilon_{MR} dr^* + \epsilon_{MY}\tilde{Y} \quad \text{(T2.2)}$$

$$\tilde{Y} = -\omega_N \epsilon_{NW}\left[\tilde{W}_0 + \lambda(1-\alpha)\tilde{Q} - (1-\lambda)\tilde{P}\right] \quad \text{(T2.3)}$$

Comparative Static Effects

- Interpretation of Table 11.2 & Figure 11.8
  - $\tilde{Y} \equiv dY/Y$, $\tilde{P} \equiv dP/P$, $\tilde{Q} \equiv dQ/Q$ 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
  - Eqn. (T2.2) is the LM curve with PCM substituted
  - Eqn. (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?

- Understanding the AS curve begins in the labour market
  - write labour demand and the wage-setting rule as follows:

$$W = PF_N\left(N, \bar{K}\right)$$
$$W = W_0\left[\Omega_0 P Q^{1-\alpha}\right]^{\lambda}$$

  - In Figures A-C we look at the various cases (figures not in the book)
  - labour demand drawn linearly for convenience only

- **Figure A**:
  - $\lambda = 0$
  - increase in P from P_0 to P_1 shifts equilibrium from e_0 to e_1
  - real exchange rate has no effect
  - employment (and output) rises
  - nominal wage rate unchanged

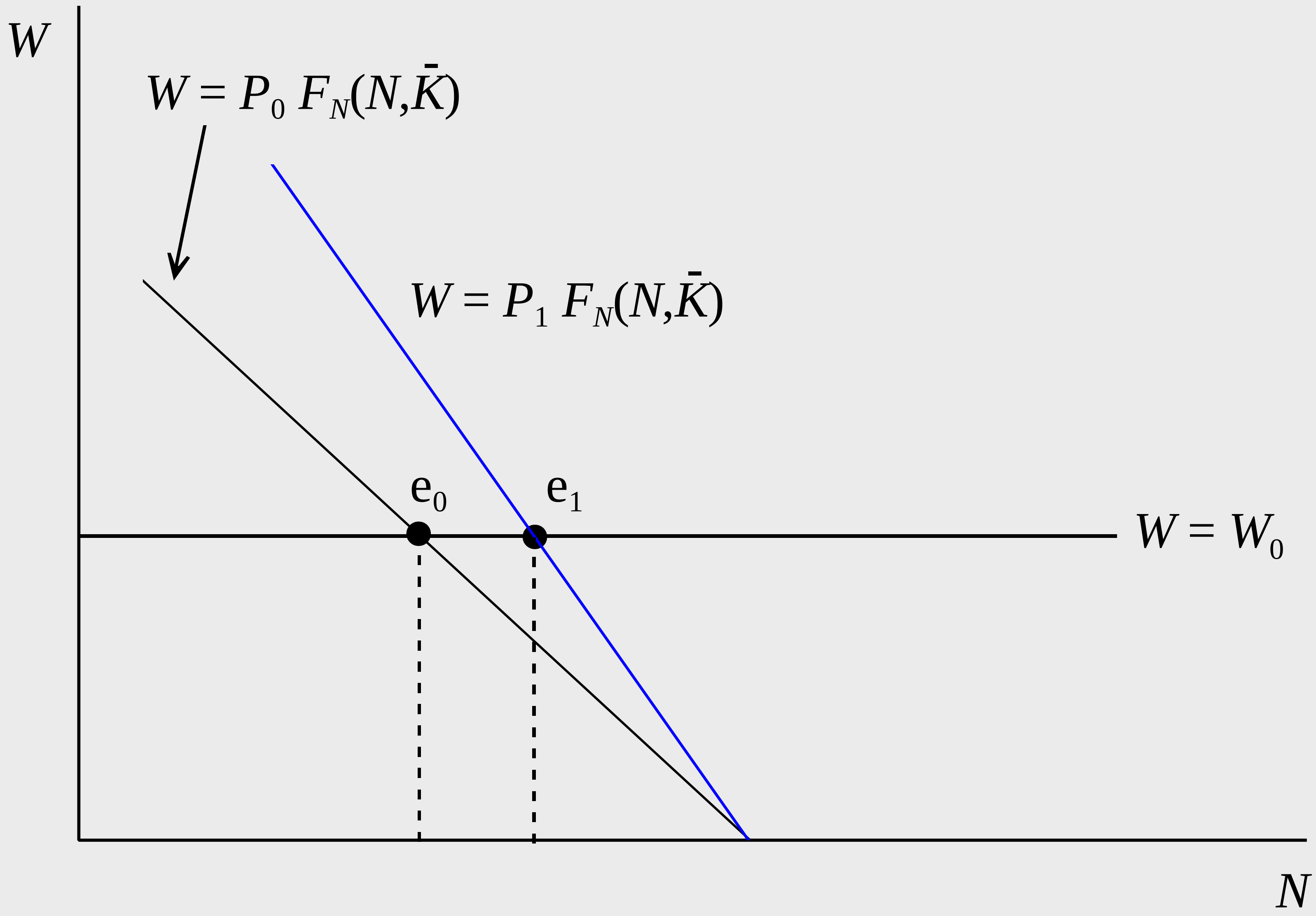

Figure A: Nominal Wage Rigidity

- **Figure B**:
  - $\lambda = 1$
  - increase in P from P_0 to P_1 shifts equilibrium from e$_0$ to e$_1$; no effect on N and Y, W/P constant
  - increase in Q from Q_0 to Q_1 shifts equilibrium from e$_0$ to e$_2$; N and Y fall, W and W/P rise

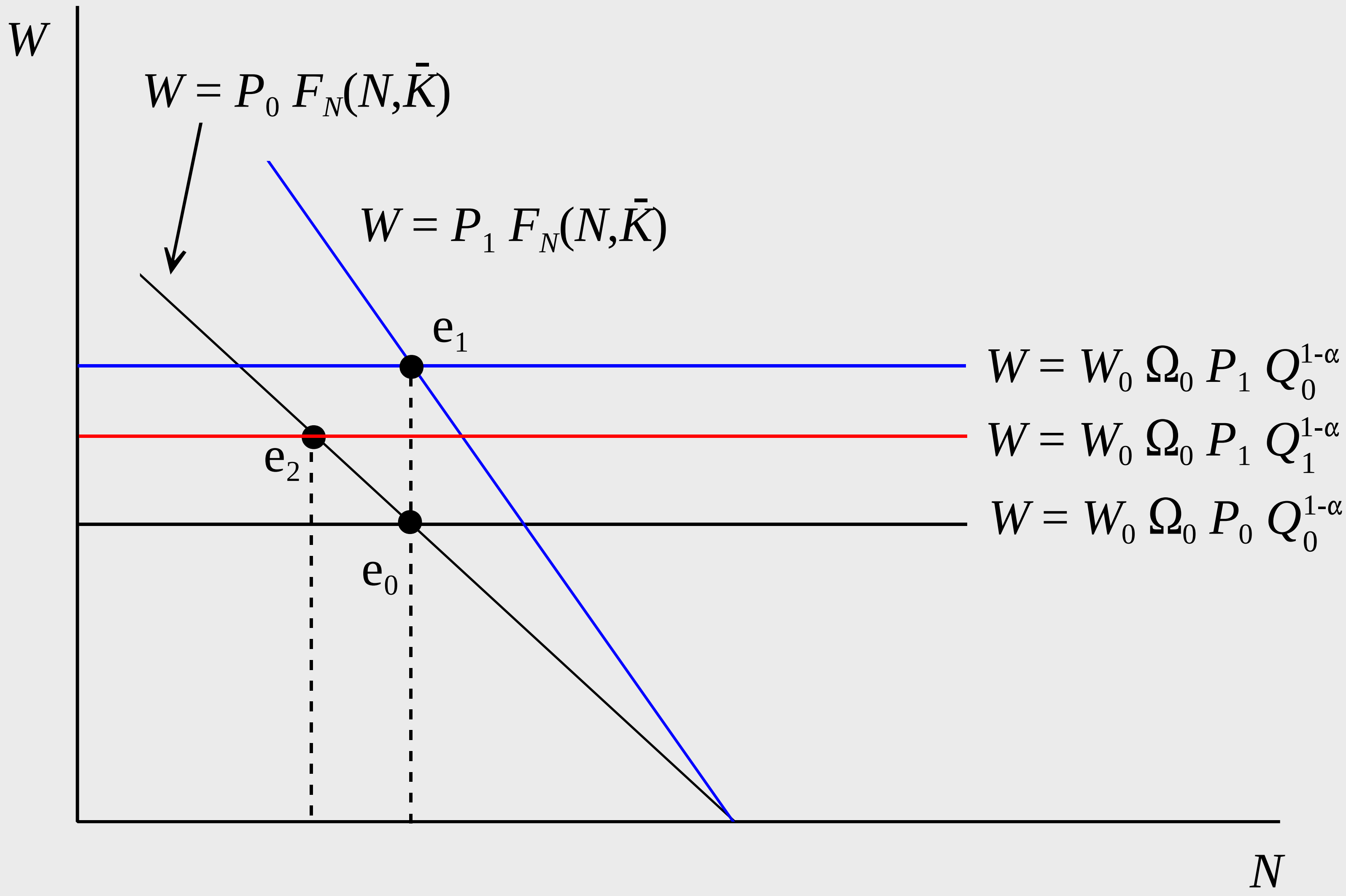

Figure B: Real Wage Rigidity

- **Figure C**:
  - $0 < \lambda < 1$
  - increase in P from P_0 to P_1 shifts equilibrium from e_0 to e_1; N, W, and Y rise but W/P falls
  - increase in Q from Q_0 to Q_1 shifts equilibrium from e_0 to e_2; N and Y fall, W and W/P rise

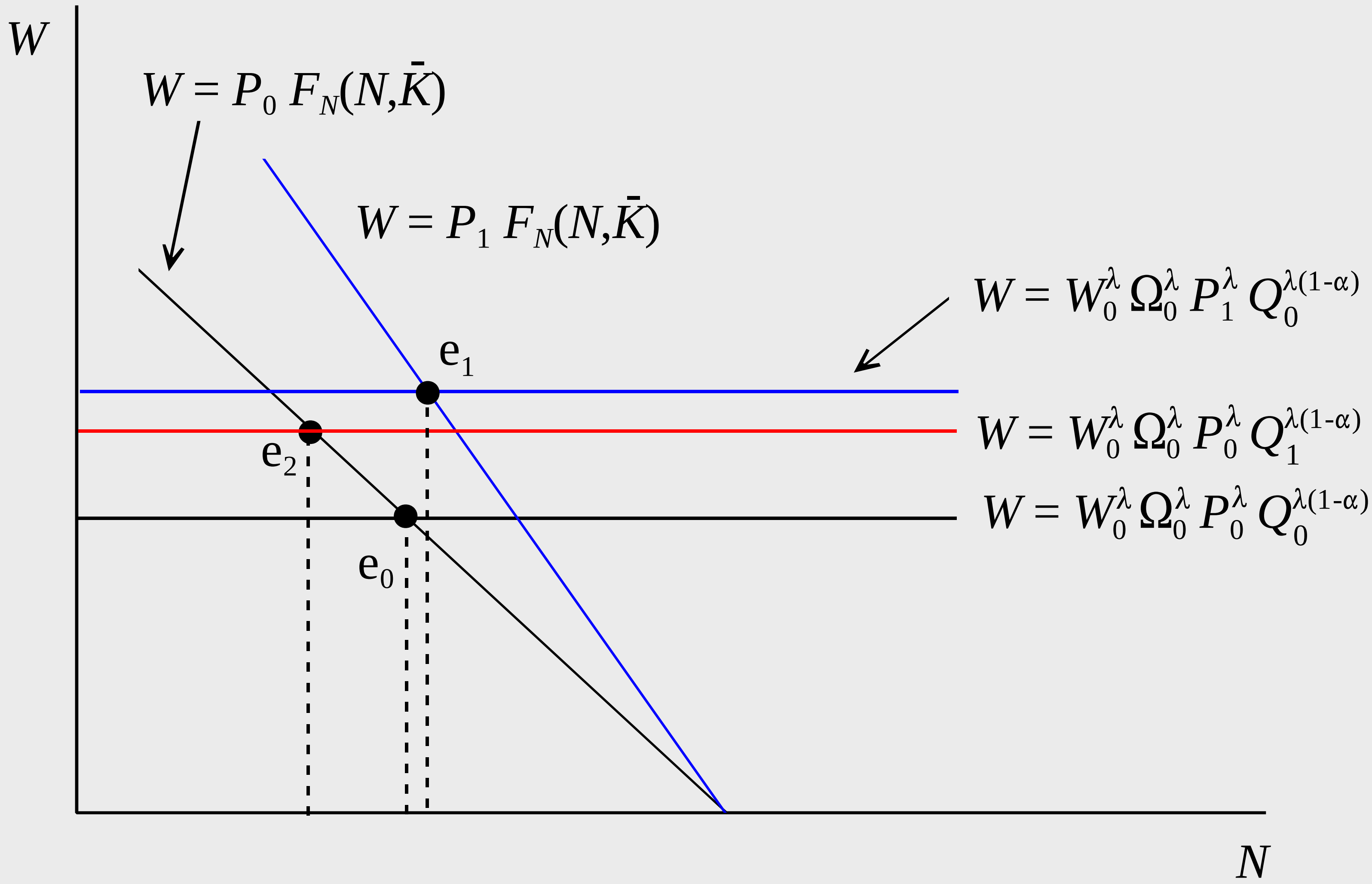

Figure C: Incomplete Wage Indexing

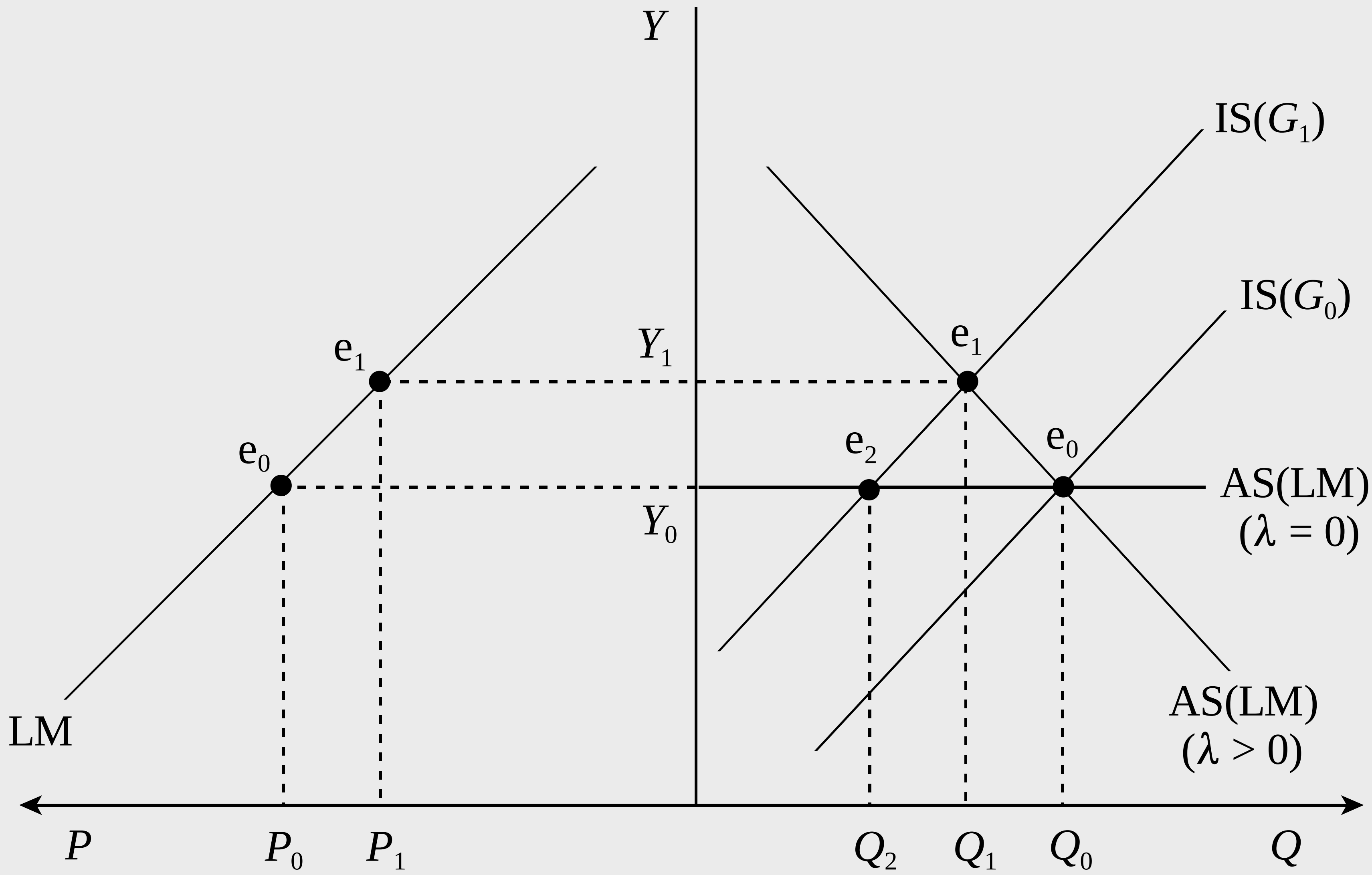

Figure 11.8: Aggregate Demand Shocks under Wage Rigidity

Fiscal Policy

- In Figure 11.8, AS(LM) is the combination of the LM curve and the AS curve:

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

  - 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)

- 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 11.3** for monetary and wage-setting shocks.

Table 11.3. Wage Rigidity and Demand and Supply Shocks

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

Shock Transmission in a Two-Country World

- 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

- Look at IS and IS* curves:

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

$$Y^* = \alpha\Omega_0 Q^{-(1-\alpha)}\left[A(r^*,Y^*)+G^*\right] + (1-\alpha)\Omega_0\left(\frac{EP^*}{P}\right)^{-\alpha}\left[A(r,Y)+G\right] \quad \text{(B)}$$

  - both own and foreign spending enters both IS curves
  - note sign of real exchange rate effects
  - since PCM implies $r = r^*$, (A) and (B) can be combined into quasi-reduced form expressions (details in text):

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

∗ 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 11.4**.

Table 11.4. A Two-Country Extended Mundell-Fleming Model

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

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

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

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

$$y = -\omega_N \epsilon_{NW} \left[w - p \right] \quad \text{(T3.5)}$$

$$y^* = -\omega_N \epsilon_{NW} \left[w^* - p^* \right] \quad \text{(T3.6)}$$

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

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

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

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

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

- assumptions: $\lambda = \lambda^* = 0$ in Table 11.4
- model can be summarized graphically **Figure 11.9**
  - AS$_N$ and AS$_N^*$ curves are:

$$y = -\omega_N \epsilon_{NW} \left[w_0 - p \right] \quad (\text{AS}_N)$$

$$y^* = -\omega_N \epsilon_{NW} \left[w_0^* - p^* \right] \quad (\text{AS}_N^*)$$

  - combining with relevant LM curves gives:

$$y = \frac{\omega_N \epsilon_{NW} \left[m + \epsilon_{MR} r^* - w_0 \right]}{1 + \omega_N \epsilon_{NW} \epsilon_{MY}} \quad (\text{LM}(\text{AS}_N))$$

$$y^* = \frac{\omega_N \epsilon_{NW} \left[m^* + \epsilon_{MR} r^* - w_0^* \right]}{1 + \omega_N \epsilon_{NW} \epsilon_{MY}} \quad (\text{LM}^*(\text{AS}_N^*))$$

and:

$$p = \frac{m + \epsilon_{MR} r^* + \omega_N \epsilon_{NW} \epsilon_{MY} w_0}{1 + \omega_N \epsilon_{NW} \epsilon_{MY}}$$

$$p^* = \frac{m^* + \epsilon_{MR} r^* + \omega_N \epsilon_{NW} \epsilon_{MW} w_0^*}{1 + \omega_N \epsilon_{NW} \epsilon_{MY}}$$

– in view of symmetry assumptions ($m = m^*$and $w_0 = w_0^*$), LM*(AS$_N^*$) and LM(AS$_N$) coincide in Figure 11.9

– combining LM(AS_N) with IS and LM*(AS_N^*) with IS* yields:

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

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

– in Figure 11.9 these curves are drawn (notice slopes)

- 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: $\zeta = \zeta^* = 1$

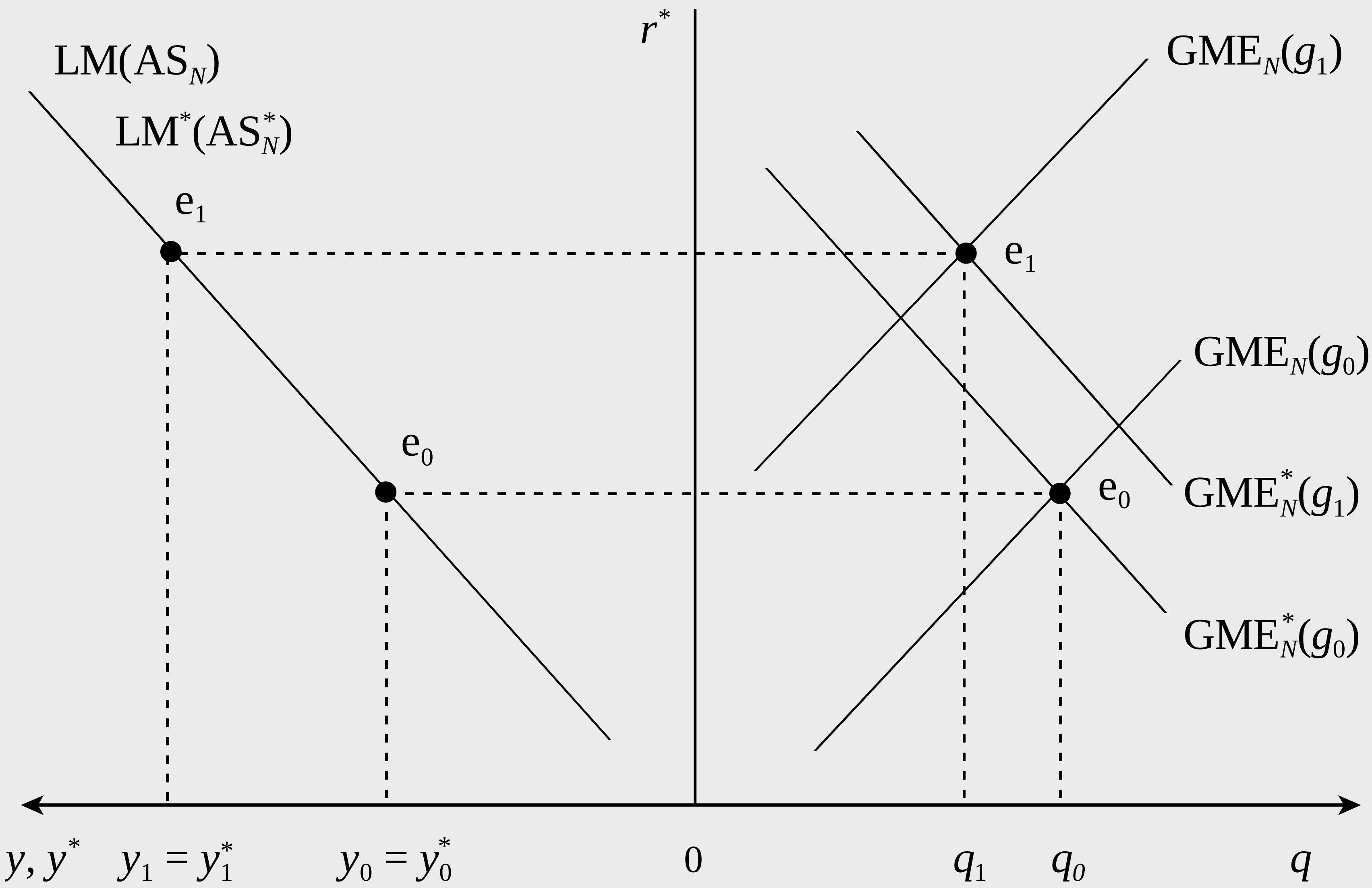

Figure 11.9: Fiscal Policy with Nominal Wage Rigidity in Both Countries

- Monetary Policy in Domestic Economy (m up)
  - see **Figure 11.10**
  - 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

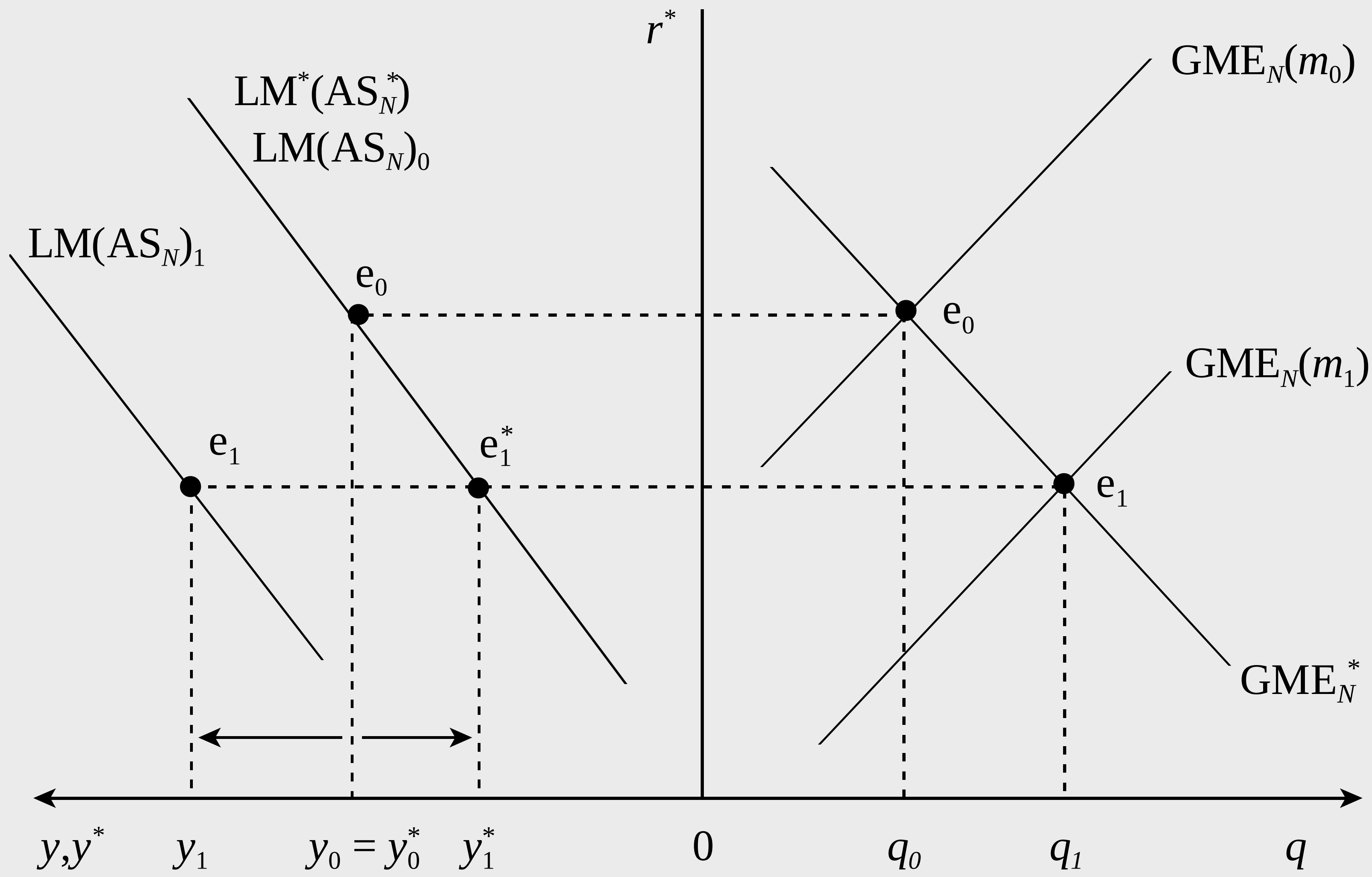

Figure 11.10: Monetary Policy with Nominal Wage Rigidity in Both Countries

Real Wage Rigidity and Economic Policy

- assumptions: $\lambda = \lambda^* = 1$ in Table 11.4
- model can be summarized graphically **Figure 11.11**
  - AS$_R$ and AS$_R^*$ curves are:

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

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

  - combining with relevant IS curves gives:

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

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

- 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

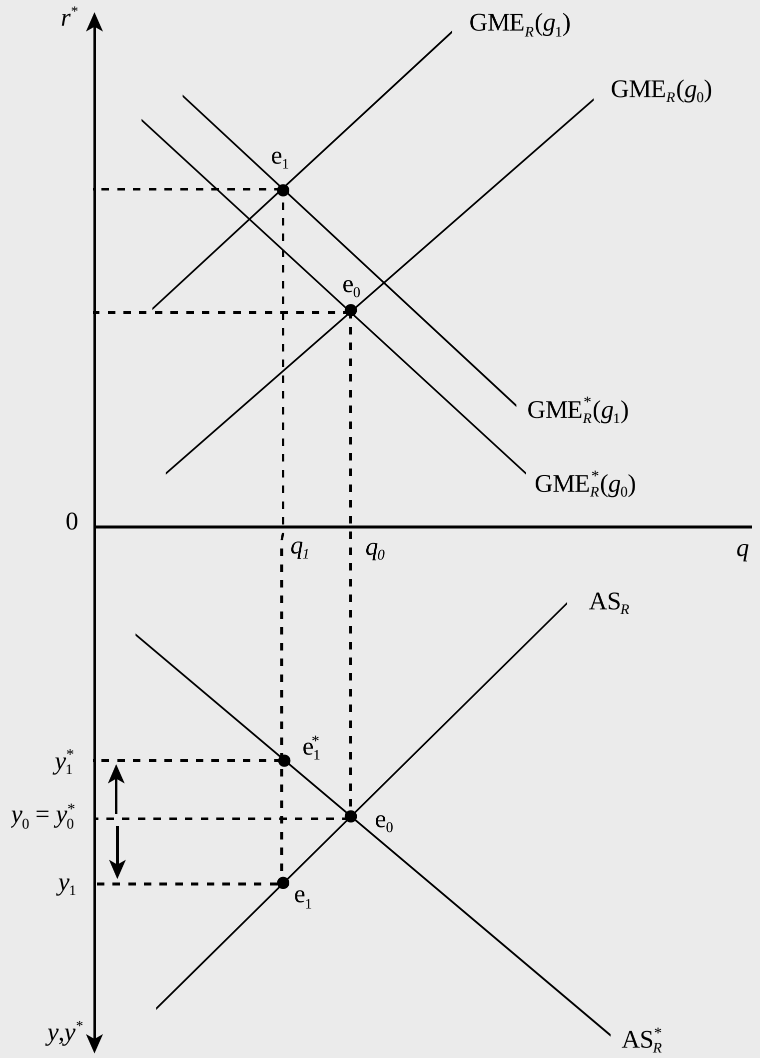

Figure 11.11: Fiscal Policy with Real Wage Rigidity in Both Countries

RWR-NWR* and Economic Policy

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

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

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

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

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

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

- Fiscal Policy in Domestic Economy (g up): see **Figure 11.12**
  - 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: $0 < \zeta^* < 1$

- Fiscal Policy in Foreign Economy (g^* up): see **Figure 11.12**
  - 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: $\zeta < 0$

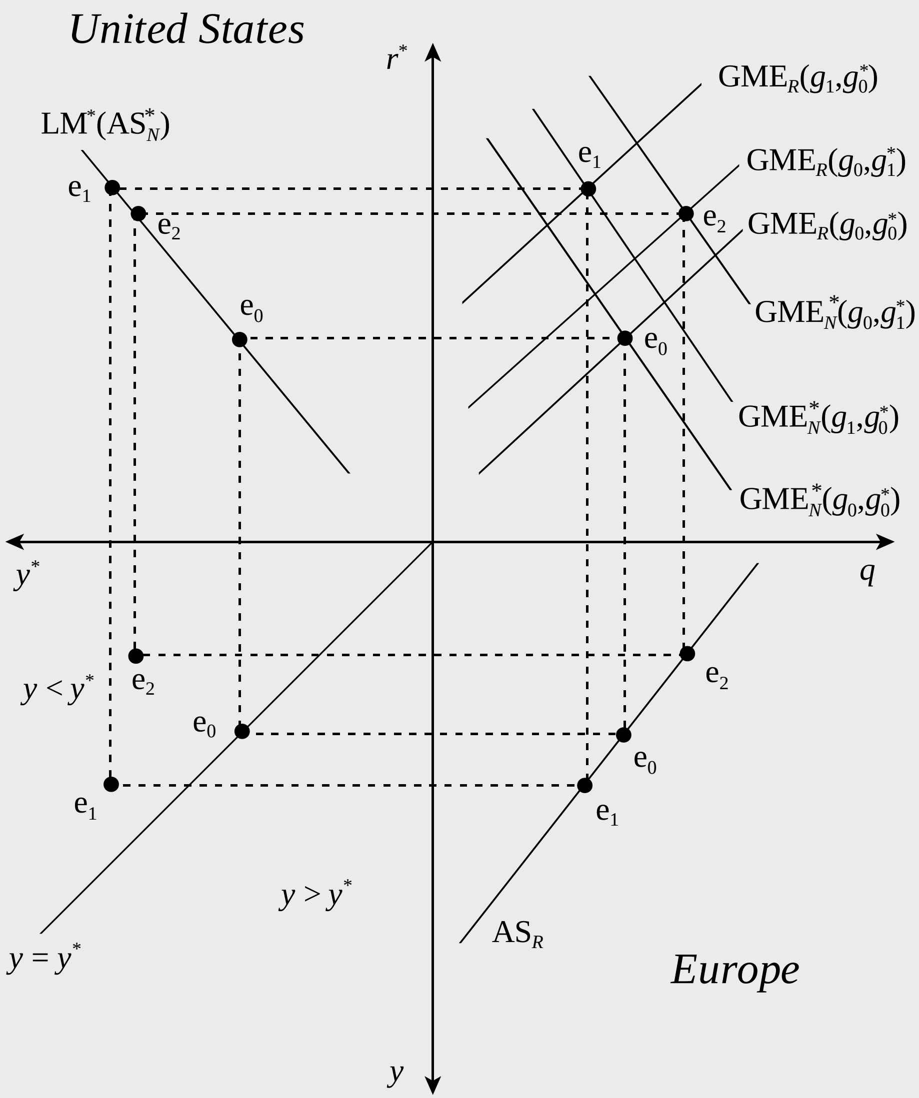

Figure 11.12: Fiscal Policy with RWR in Europe and NWR in the US

- Monetary Policy in Domestic Economy (m up) has no real effects
- Monetary Policy in Foreign Economy (m^* up): see **Figure 11.13**
  - 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)

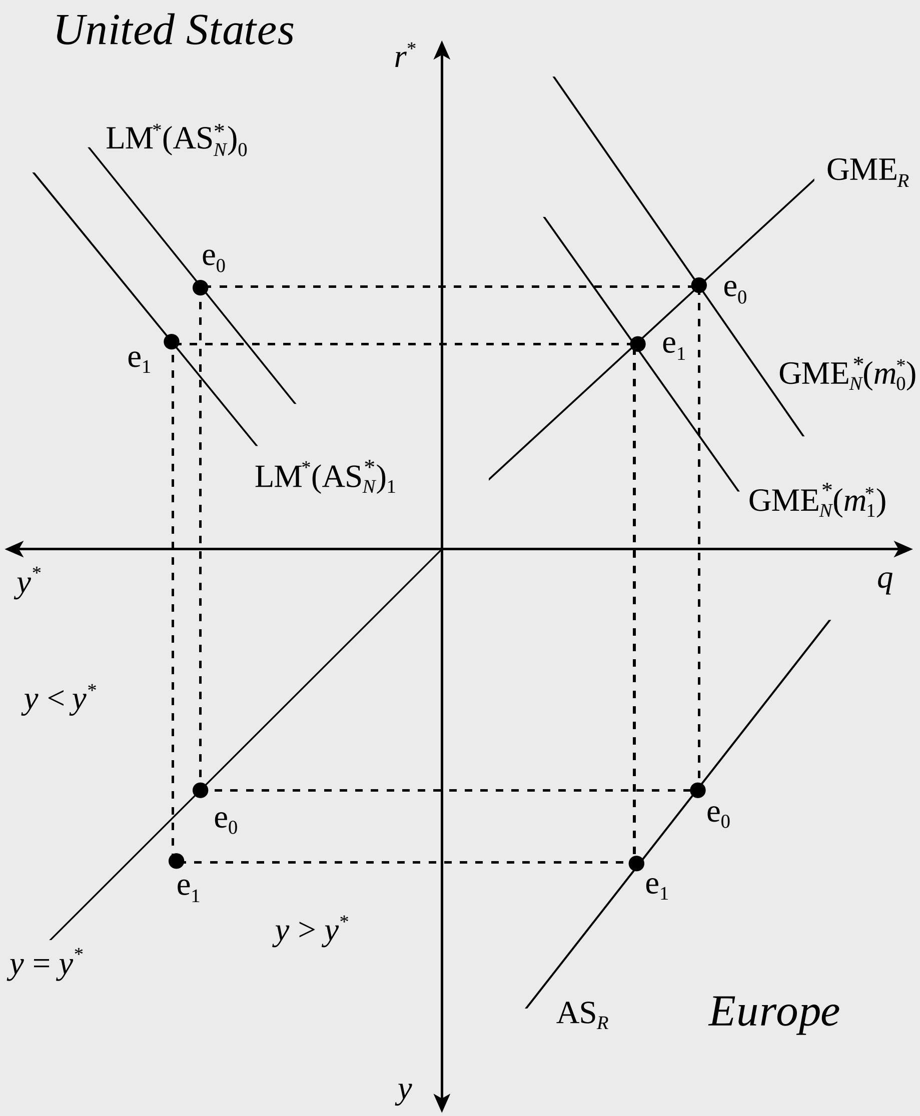

Figure 11.13: Monetary Policy with RWR in Europe and NWR in the US

International Policy Coordination

- Policy question: is international coordination of policy welfare enhancing or not?
  - international spillovers
  - quantitative theory of economic policy [cf. Chapter 10]
- Summarize the insights from symmetric two-country model as follows:

$$y = g + \zeta g^* \quad \text{(A)}$$

$$y^* = g^* + \zeta^* g \quad \text{(B)}$$

  - 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 $0 < \zeta^* < 1$

- Objective function domestic policy maker:

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

  - L_G is the loss function (to be minimized subject to trade-off (A))
  - $\bar{y}$ is the target output level
  - small government sector desired

- Objective function foreign policy maker:

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

  - L_G^* is the loss function (to be minimized subject to trade-off (B))
  - $\bar{y}$ is the target output level (same as home country)
  - small government sector desired

Uncoordinated Fiscal Policy

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

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

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

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

  - (RR) and (RR*) are so-called *reaction functions*: a country's best response, given what the other country does.

- see **Figures 11.14-11.15** for the two pure cases. Non-cooperative Nash Equilibrium is at the intersection of RR and RR*
- for symmetric case ($\zeta = \zeta^*$) we have:

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

- NWR in both countries: $\zeta = \zeta^* = 1$
  - **Figure 11.14**: reaction functions downward sloping
  - unique non-cooperative Nash equilibrium at point N
  - stable: possible sequence is $g_0^* \longrightarrow g_1 \longrightarrow g_1^* \longrightarrow g_2 \longrightarrow \cdots \; g_{N-1}^* \longrightarrow g_N$
- RWR in both countries: $\zeta = \zeta^* < 0$
  - **Figure 11.15**: reaction functions upward sloping
  - unique stable non-cooperative Nash equilibrium at point N

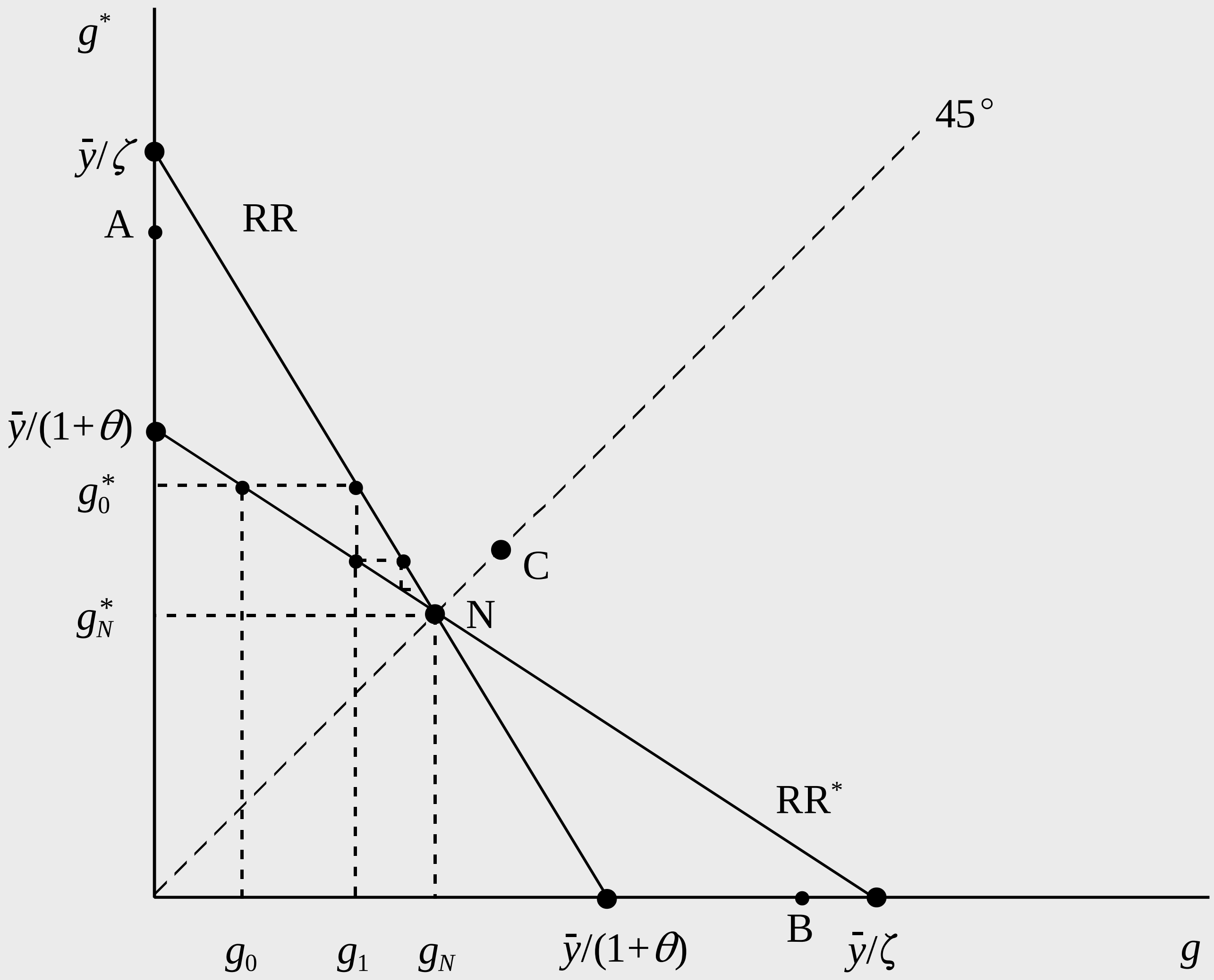

Figure 11.14: International Coordination of Fiscal Policy under Nominal Wage Rigidity in Both Countries

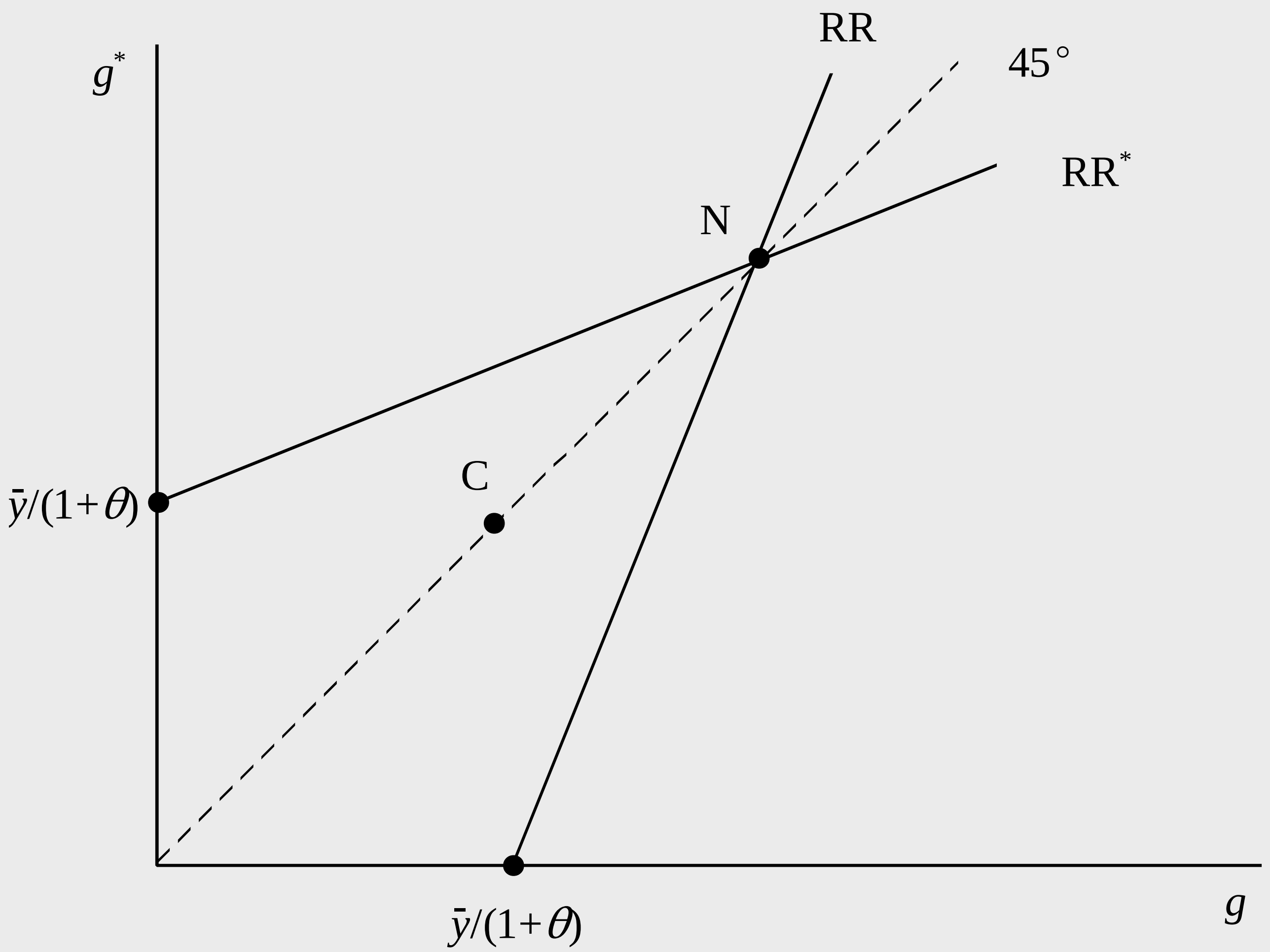

Figure 11.15: International Coordination of Fiscal Policy under Real Wage Rigidity in Both Countries

Coordinated Fiscal Policy

- 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 (A)-(B)
  - formally:

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

– 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:

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

- 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 11.14)
  - 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 11.15)
  - 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

- 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:

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

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

- 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)

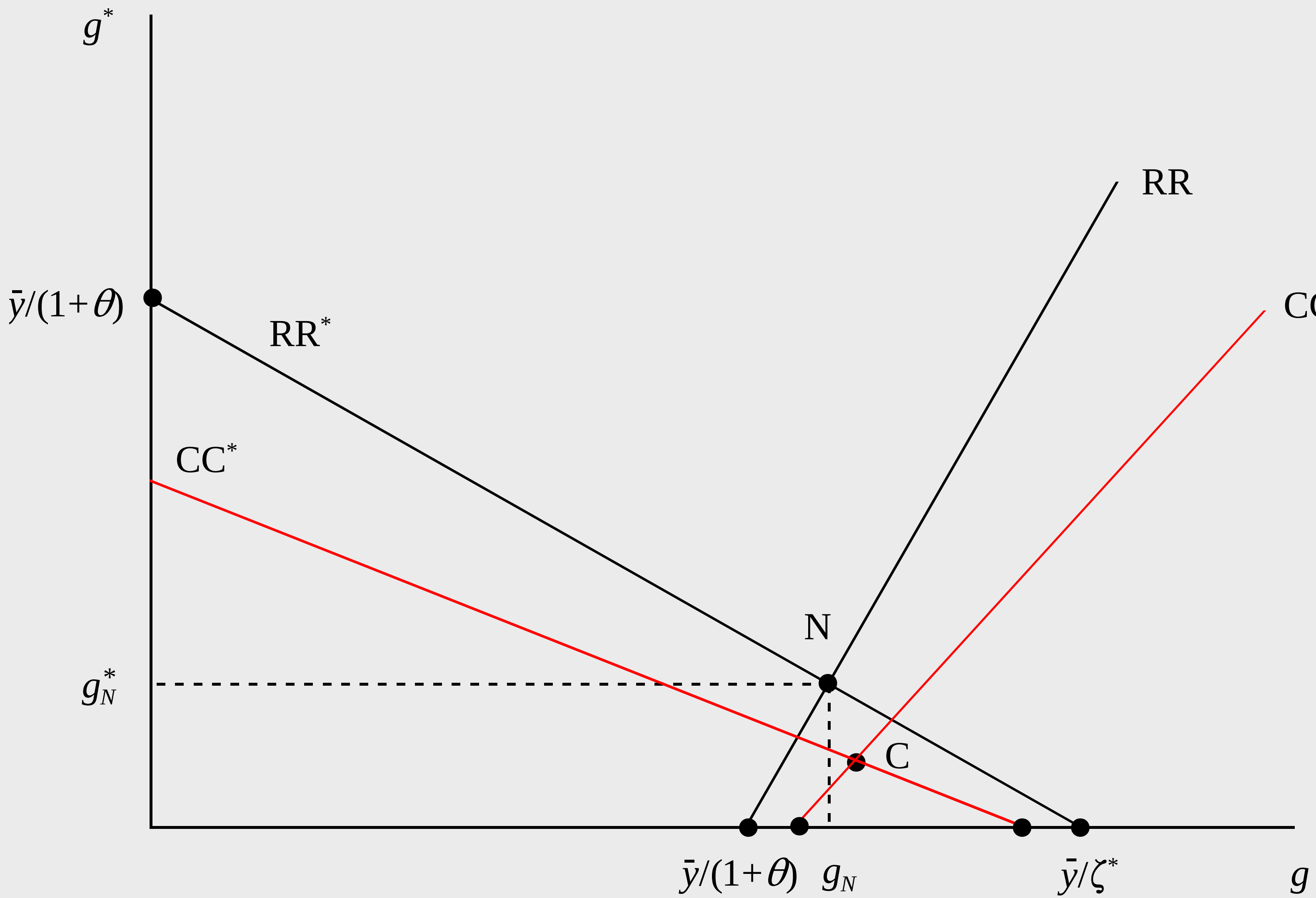

Figure D: Asymmetric Case (RWR, NWR*)

Forward-Looking Behaviour in International Financial Markets

- Look at yields on two types of portfolio investment:

$$\text{yield gap} \equiv (1+r) - (1+r^*)\frac{E_1^e}{E_0} = (1+r) - (1+r^*)\left(1+\frac{\Delta E^e}{E_0}\right)$$

$$= (1+r) - \left(1 + r^* + \frac{\Delta E^e}{E_0} + r^*\frac{\Delta E^e}{E_0}\right) \approx r - \left(r^* + \frac{\Delta E^e}{E_0}\right) \quad \text{(YG)}$$

  - 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:

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

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

- Arbitrage in world financial marlets 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

- **Table 11.5** 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 11.16**
- Derivation:

– quasi-reduced form expressions for r and y:

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

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

– derive dynamic system for e and p:

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

– draw equilibrium loci $\dot{e} = 0$ and $\dot{p} = 0$

$$e + p^* = \frac{-(1 - \epsilon_{MY}\epsilon_{YQ})p - \epsilon_{MY}\epsilon_{YG}g}{\epsilon_{MY}\epsilon_{YQ}} + \frac{m + (\epsilon_{MR} + \epsilon_{MY}\epsilon_{YR})r^*}{\epsilon_{MY}\epsilon_{YQ}} \qquad \text{(Edot)}$$

$$e + p^* = \frac{(\epsilon_{YR} + \epsilon_{MR}\epsilon_{YQ})p - \epsilon_{MR}\epsilon_{YG}g}{\epsilon_{MR}\epsilon_{YQ}} + \frac{-\epsilon_{YR}m + (\epsilon_{MR} + \epsilon_{MY}\epsilon_{YR})\bar{y}}{\epsilon_{MR}\epsilon_{YQ}} \qquad \text{(Pdot)}$$

– 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

Table 11.5. The Dornbusch Model

$$y = -\epsilon_{YR} r + \epsilon_{YQ} \left[p^* + e - p \right] + \epsilon_{YG} g \quad \text{(T5.1)}$$

$$m - p = -\epsilon_{MR} r + \epsilon_{MY} y \quad \text{(T5.2)}$$

$$r = r^* + \dot{e}^e \quad \text{(T5.3)}$$

$$\dot{p} = \phi \left[y - \bar{y} \right] \quad \text{(T5.4)}$$

$$\dot{e}^e = \dot{e} \quad \text{(T5.5)}$$

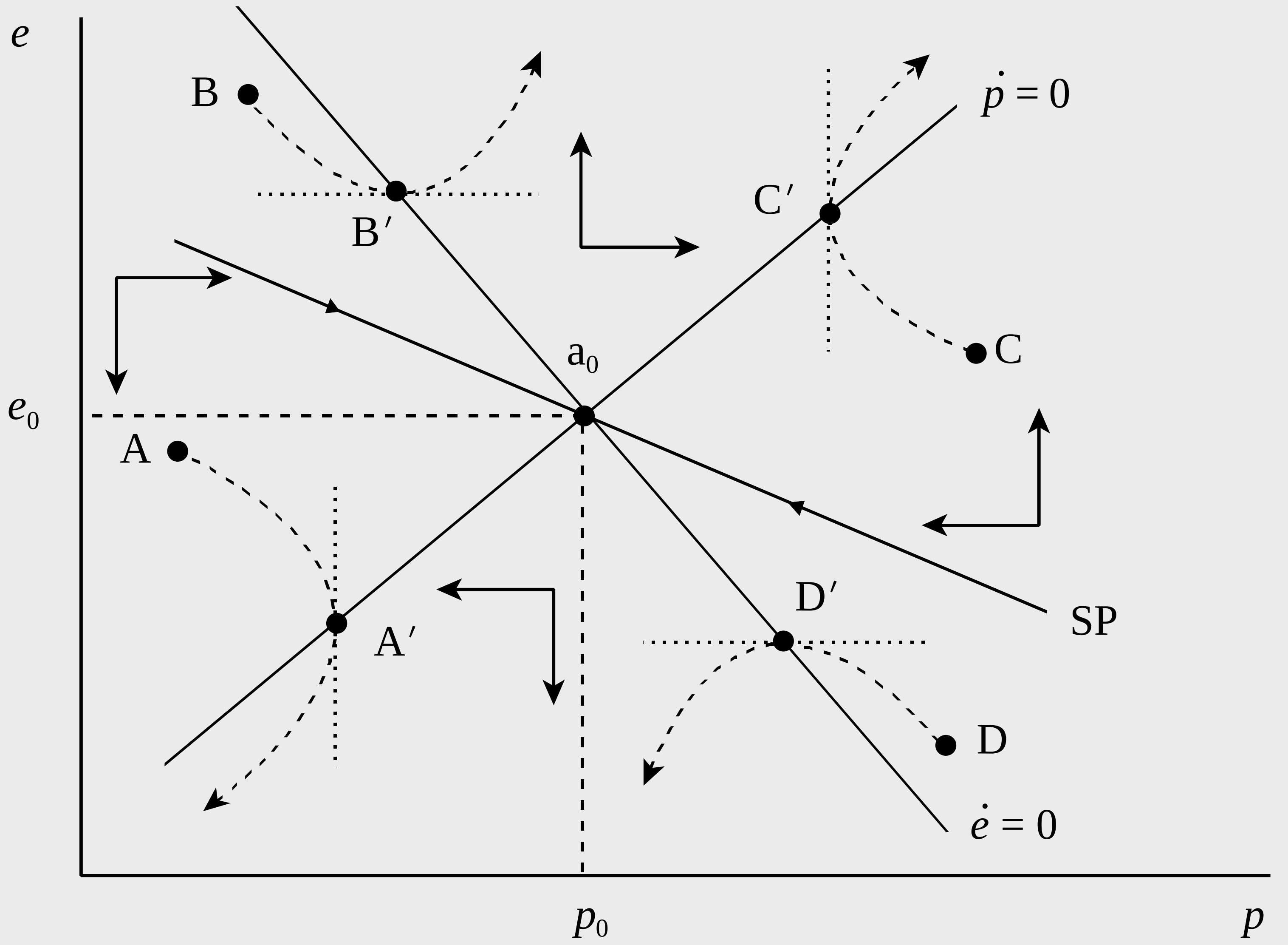

Figure 11.16: Phase Diagram for the Dornbusch Model

Economic Policy in the Dornbusch Model

- Under PFH timing of policy is crucial (as in perfect foresight models of Chapter 4)
- Fiscal policy: unanticipated / permanent increase in g
  - see **Figure 11.17**
  - $\dot{e} = 0$ 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

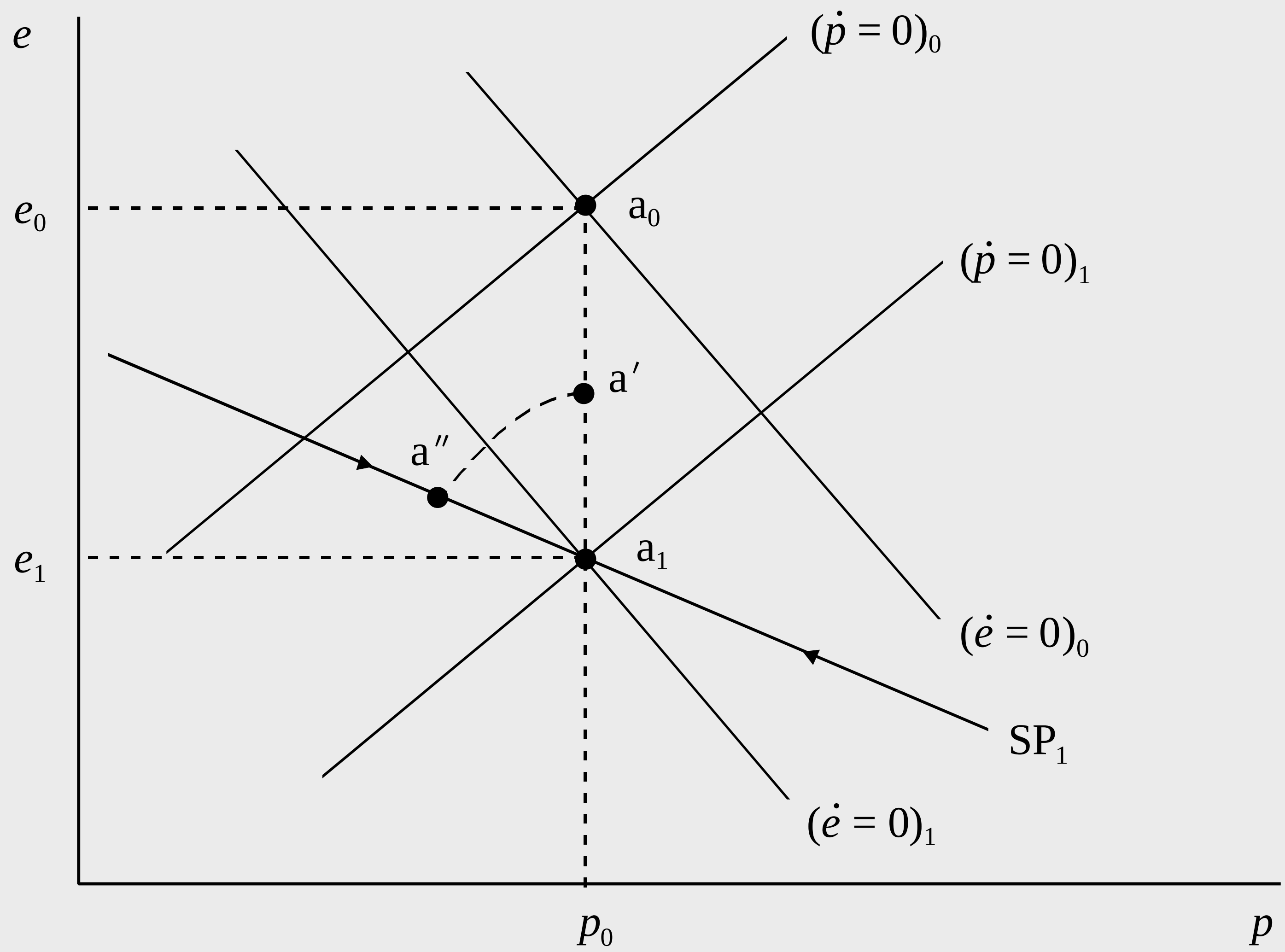

Figure 11.17: Fiscal Policy in the Dornbusch Model

- Monetary policy: unanticipated / permanent increase in m
  - see **Figure 11.18**
  - $\dot{e} = 0$ 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

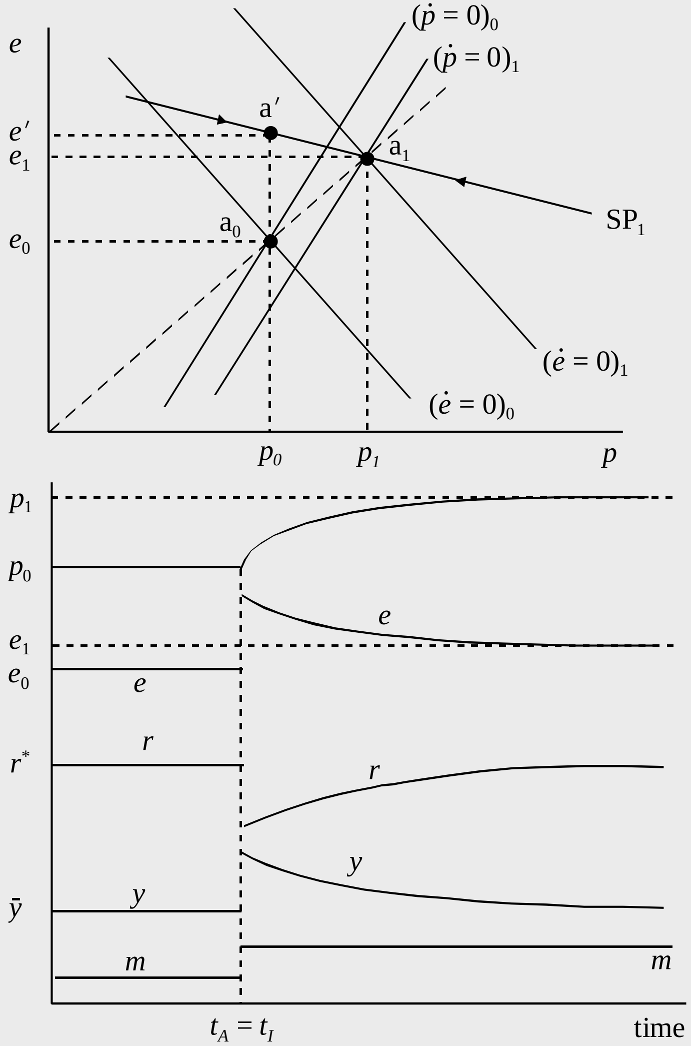

Figure 11.18: Monetary Policy in the Dornbusch Model

Overshooting: Sensitivity Analysis

- 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
  - $\phi \rightarrow \infty$, so $y = \bar{y}$ always
  - domestic interest rate:

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

– (unstable) differential equation for e:

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

– unanticipated / permanent increase in m results in a once-off increase in e (depreciation): no overshooting!

– see **Figure 11.19**

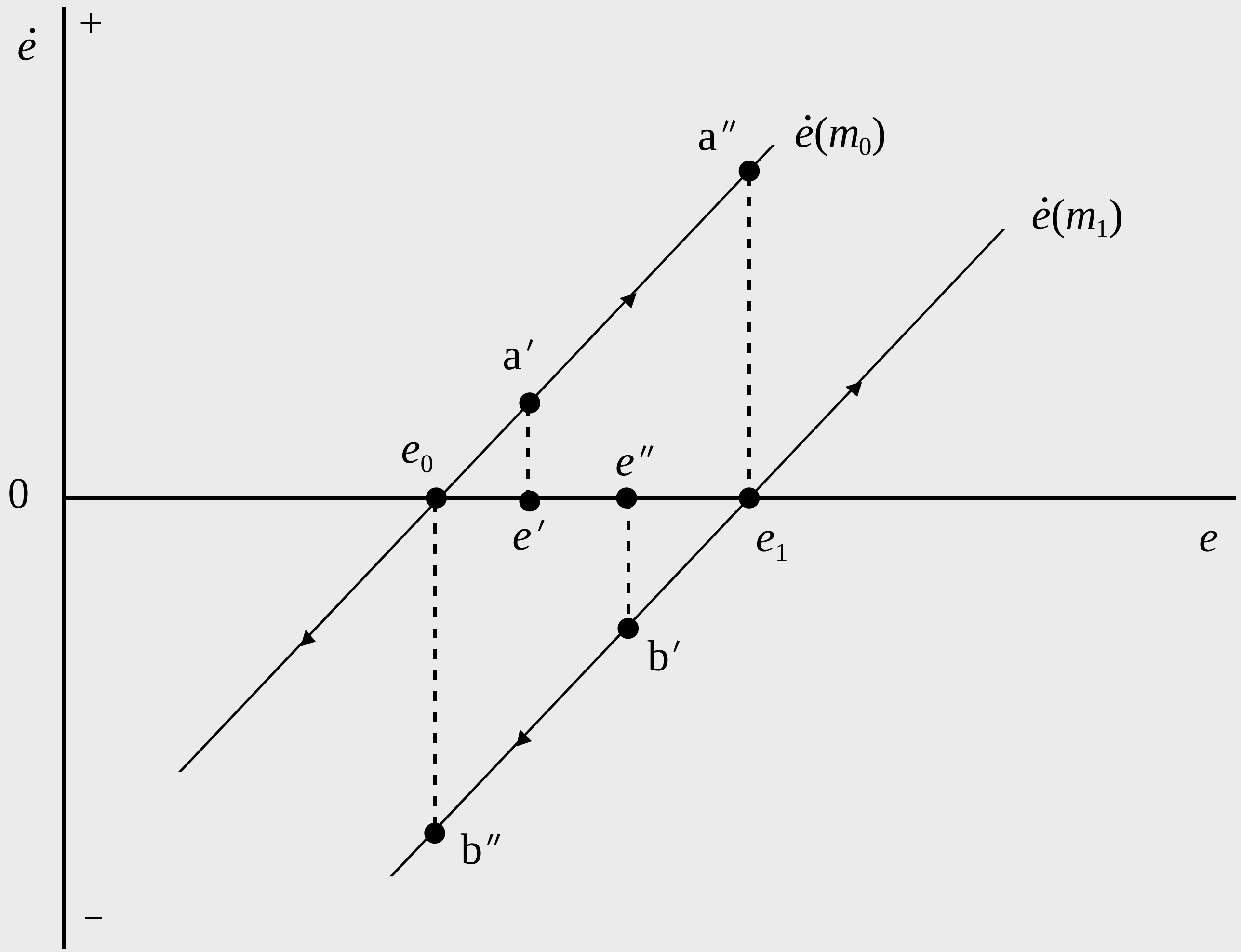

Figure 11.19: Exchange Rate Dynamics with Perfectly Flexible Prices

- Imperfect Capital Mobility in the Dornbusch model
  - Frenkel & Rodriguez (1982)
  - model given in **Table 11.6**
  - phase diagram with low capital mobility in **Figure 11.20**: no overshooting
  - phase diagram with high capital mobility in **Figure 11.21**: overshooting
  - lesson: sticky prices necessary but not sufficient condition for overshooting result to occur

Table 11.6. The Frenkel-Rodriguez Model

$$y^d = \bar{y} + \epsilon_{DQ}\left[p^* + e - p\right] \tag{T6.1}$$

$$r = \epsilon_{RY}\bar{y} - \epsilon_{RM}\left[m - p\right] \tag{T6.2}$$

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

$$X = \epsilon_{XQ}\left[p^* + e - p\right] \tag{T6.4}$$

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

$$KI + X = 0 \tag{T6.6}$$

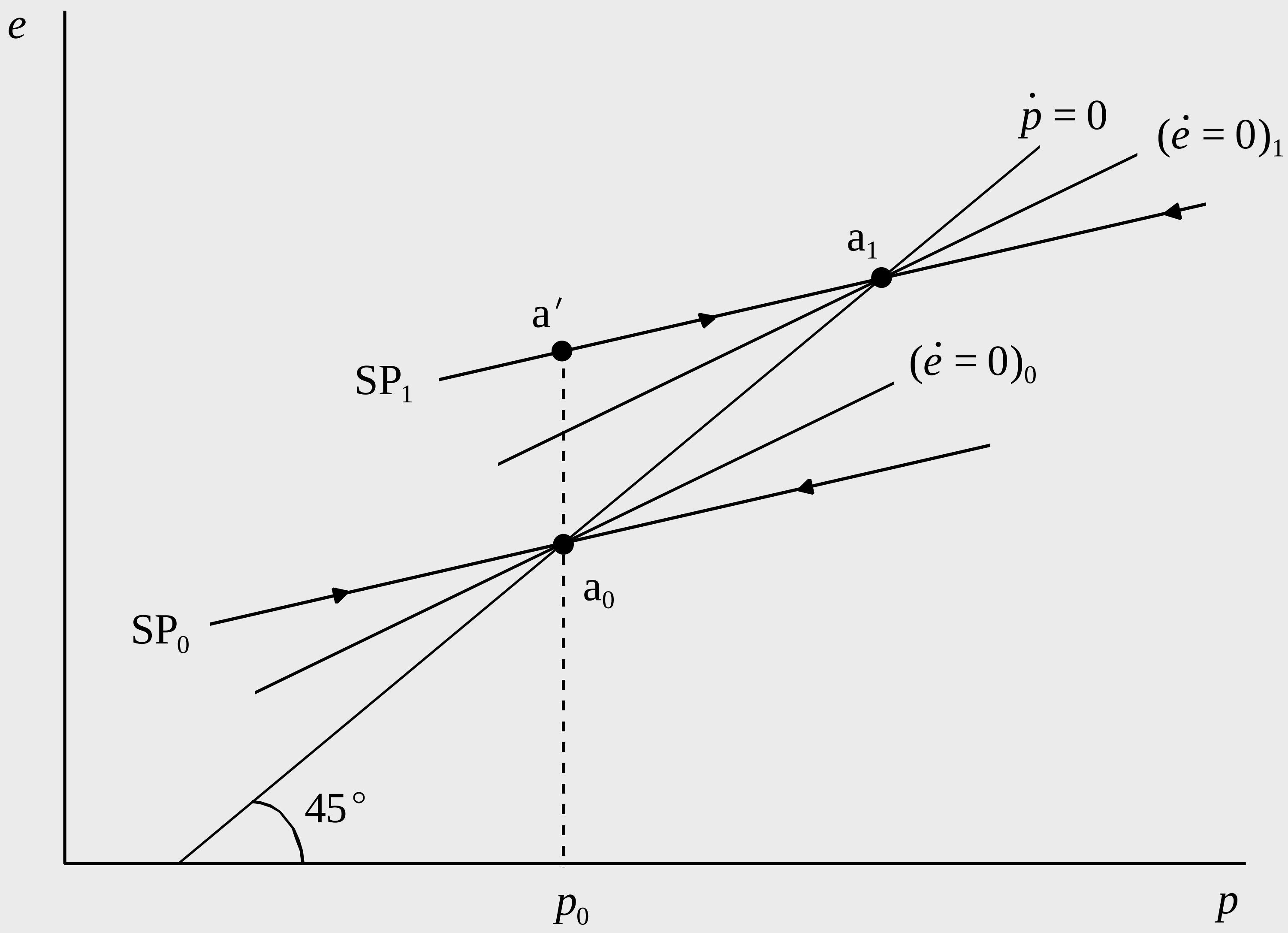

Figure 11.20: Exchange Rate Dynamics with Low Capital Mobility

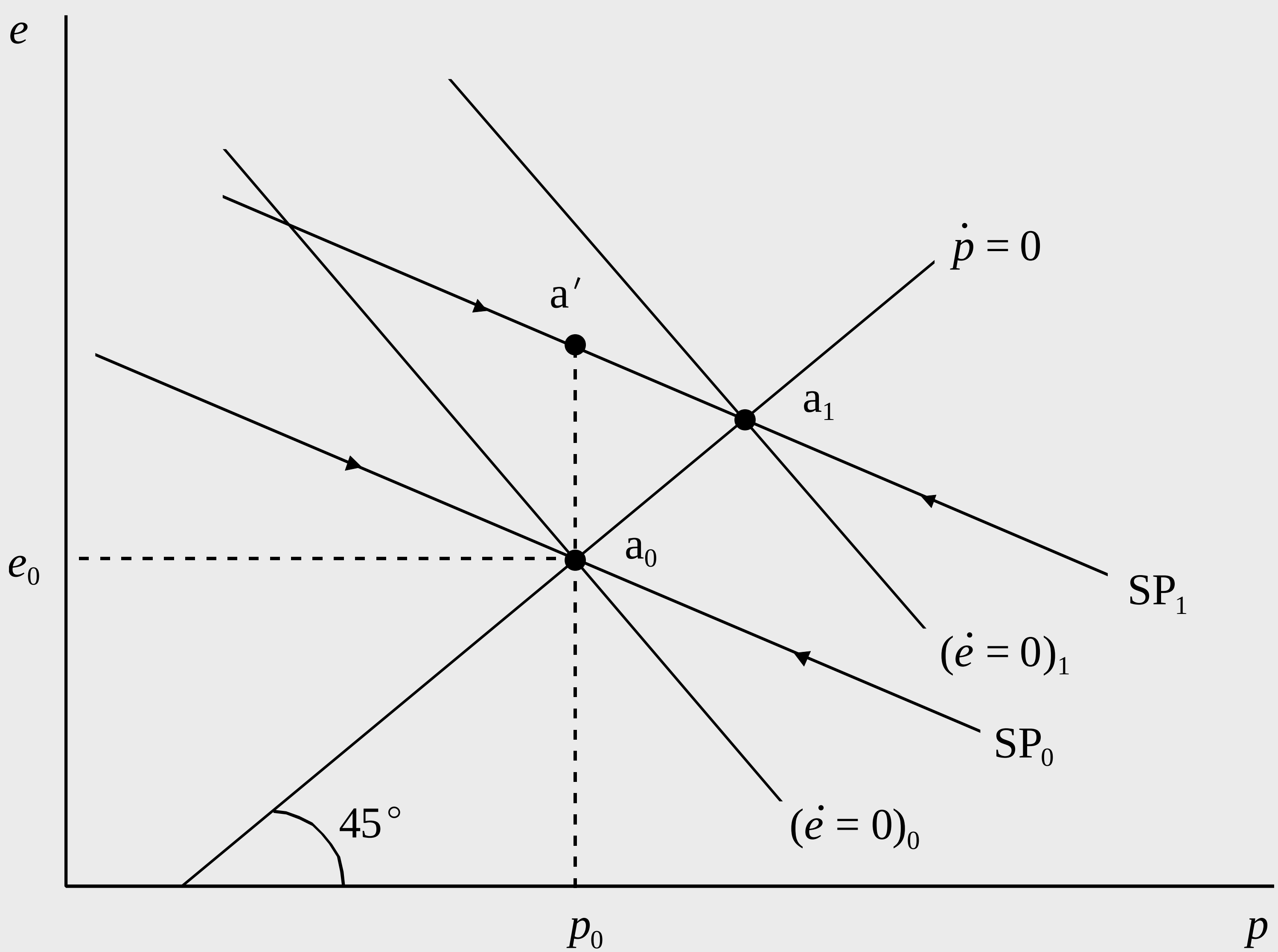

Figure 11.21: Exchange Rate Dynamics with High Capital Mobility

- 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 11.18: overshooting
  - phase diagram with strong accommodation (δ high) in **Figure 11.22**: no overshooting
  - lesson: by engaging in monetary accommodation, the policy maker can prevent overshooting to occur

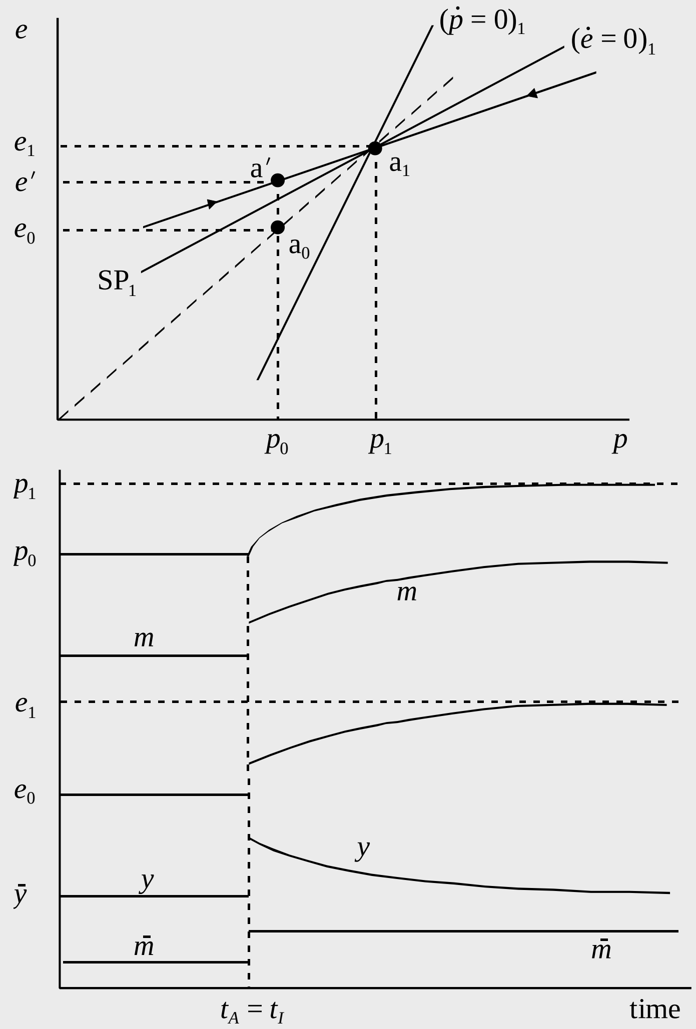

Figure 11.22: Monetary Accommodation and Undershooting

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

- forward-looking sticky-price model with perfect capital mobility
  - overshooting: financial shocks cause volatility
  - determinants of overshooting