SUGGESTED SOLUTION SØK2009 SPRING 2019

Question a)

Output market equilibrium: The DD schedule

Aggregate demand:

$$D = C + I + G + CA \quad , \text{where } CA = EX - IM$$

Consumption:

$$C = \underset{+}{C(Y-T)} \quad , \text{where } Y-T = Y^d$$

$$\frac{\partial C}{\partial (Y-T)} > 0 \quad : \text{Higher disposable income} \Rightarrow \text{Higher consumption}$$

Current account:

$$CA = CA\left(\underset{+}{\frac{EP^*}{P}}, \underset{-}{Y-T}\right) \quad , \text{where } \frac{EP^*}{P} \text{ is the real exchange rate}$$

$$\frac{\partial CA}{\partial \frac{EP^*}{P}} > 0 \quad : \text{Marshall-Lerner condition}$$

$$\frac{\partial CA}{\partial (Y-T)} < 0 \quad : Y-T \uparrow \Rightarrow \text{More imports} \Rightarrow CA \downarrow$$

D = total demand

C = consumption

I = investment

G = public expenditures

CA = current account

EX = export

IM = import

T = taxes

Y = output/income

E = exchange rate

p = domestic price level

p* = foreign price level

The equation for aggregate demand follows as:

$$D = C(Y-T) + I + G + CA\left(\frac{EP^*}{P}, Y-T\right)$$

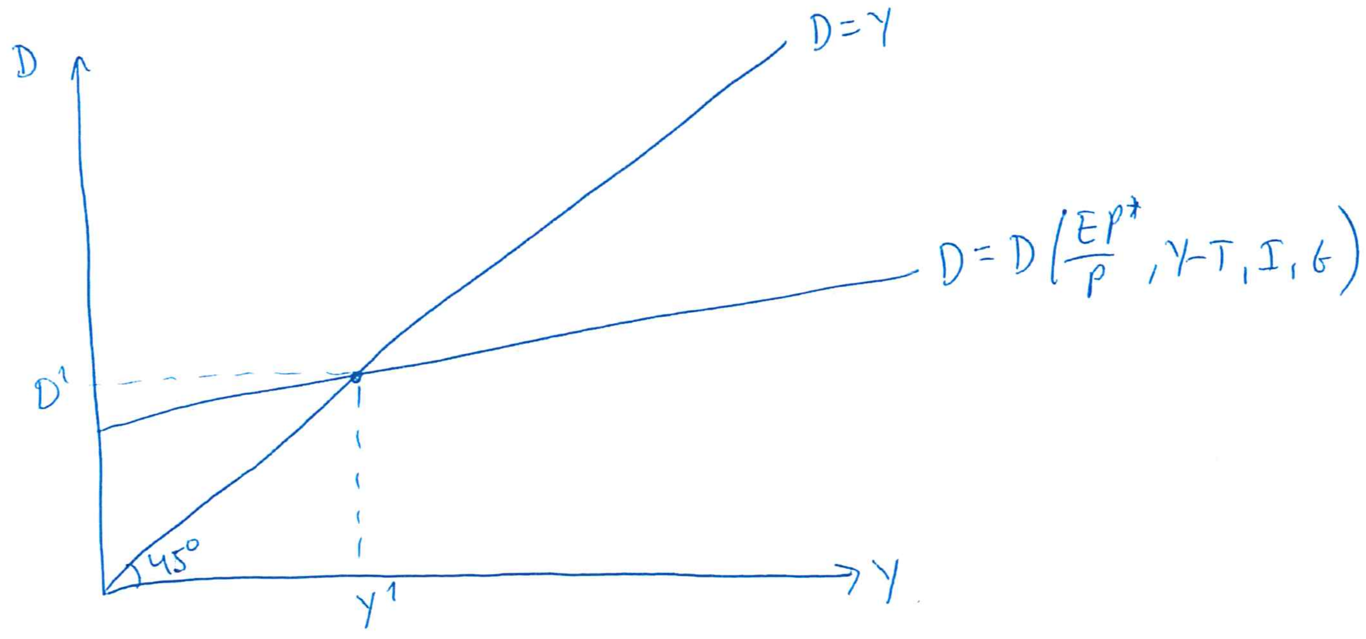
$$\Rightarrow D = D\left(\frac{EP^*}{P}, Y-T, I, G\right)$$

Output market equilibrium:

$$Y = D$$

$$\Rightarrow Y = C(Y-T) + I + G + CA\left(\frac{EP^*}{P}, Y-T\right) \qquad (1)$$

Graphically:



The aggregate demand curve is upward sloping: $Y \uparrow \Rightarrow D \uparrow$

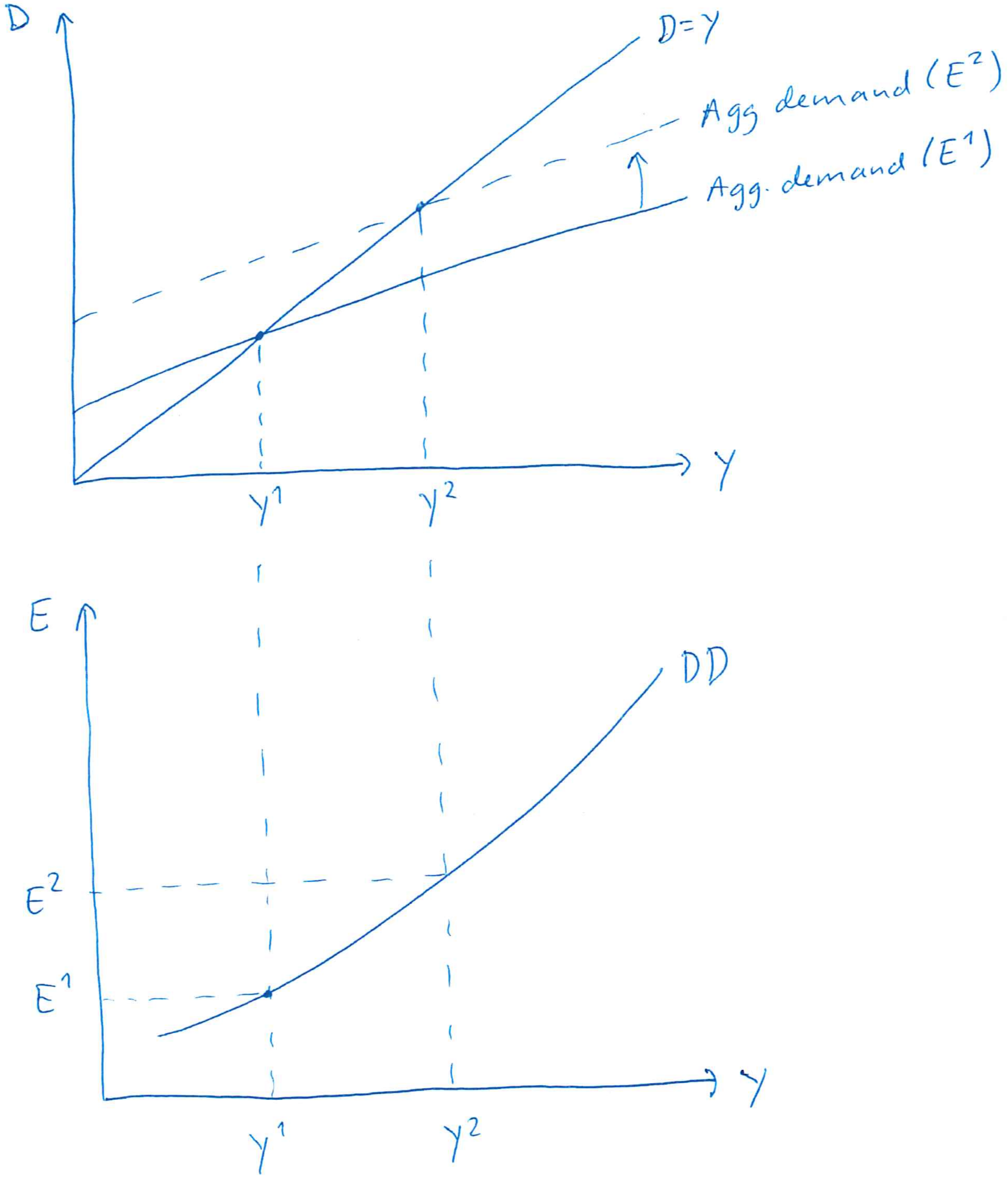
The slope of the curve is less than one

The DD schedule shows all combinations of output and the exchange rate where the output market is in equilibrium

Assume that P and P^* are fixed.

What is the impact on output (Y) of a currency depreciation, $E^1 \to E^2$ where $E^2 > E^1$?

Graphically:



The DD schedule is upward sloping since a currency depreciation ($E\uparrow$) leads to higher output ($Y\uparrow$)

Mechanism:

$$E\uparrow \Rightarrow \frac{EP^*}{P}\uparrow \Rightarrow CA\uparrow \Rightarrow Y\uparrow$$

Exchange rate depreciation is expansionary.

<u>Analytically:</u>

Differentiate equation (1) with respect to Y and E:

$$Y = C(Y-T) + I + G + CA\left(\frac{EP^*}{P}, Y-T\right)$$

$$\Rightarrow dY = C_Y \cdot dY + CA_E \cdot \frac{P^*}{P} \cdot dE + CA_Y \cdot dY$$

where

$$C_Y = \frac{\partial C(Y-T)}{\partial Y} > 0 \qquad CA_E = \frac{\partial CA\left(\frac{EP^*}{P}, Y-T\right)}{\partial\left(\frac{EP^*}{P}\right)} > 0$$

$$CA_Y = \frac{\partial CA\left(\frac{EP^*}{P}, Y-T\right)}{\partial Y} < 0$$

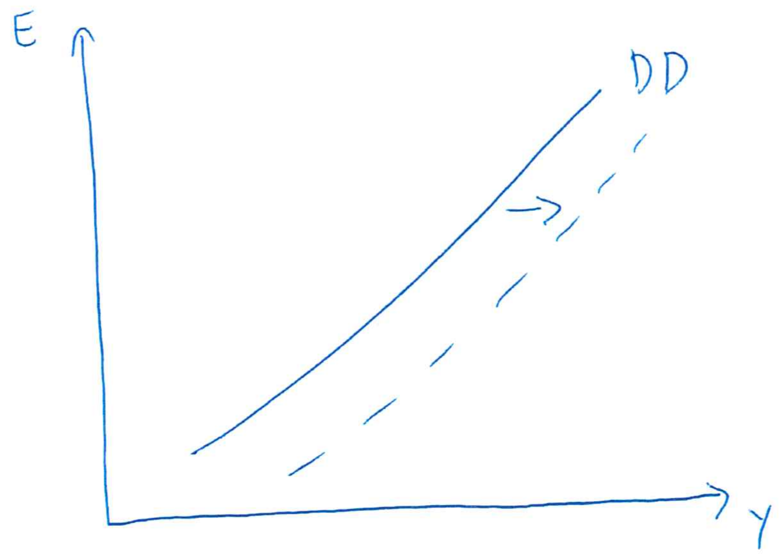
$$\Rightarrow dY(1 - C_Y - CA_Y) = CA_E \cdot \frac{P^*}{P} dE$$

$$\Rightarrow \frac{dY}{dE} = \frac{CA_E \cdot \frac{P^*}{P}}{1 - C_Y - CA_Y} > 0$$

(Assuming that $1 - C_Y - CA_Y > 0$)

Shifts in the DD schedule:

→ Changes in G, T, I, P or P^*



Outward shift:
$G\uparrow$, $T\downarrow$, $I\uparrow$,
$P\downarrow$, $P^*\uparrow$

Also:
- changes in the consumption function parameters
- demand shift between foreign and domestic goods not related to price changes

Question b)

To answer the question, we will use the AA-DD model.

The DD schedule was derived in question a).

To derive the AA schedule, we must first present the foreign exchange market and the money market (covered in chapters 14 and 15 in the Krugman et al textbook).

The foreign exchange model

→ describes the equilibrium in the foreign exchange market

(i) $RR_{\$} = R_{\$}$

(ii) $RR_{€} = R_{€} + \dfrac{E^e - E}{E}$

(iii) $RR_{\$} = RR_{€}$

where:

$RR_\$$: return on dollar deposits

$RR_€$: expected return on euro deposits

E : exchange rate

E^e : expected exchange rate

To simplify notation: the subscript $/€ is dropped.

3 equations, 3 endogenous variables: $RR_\$, RR_€, E$

Exogenous variables: $R_\$, R_€, E^e$

Solving the model: (i) and (ii) into (iii)

$$R_\$ = R_€ + \frac{E^e - E}{E}$$

→ The uncovered interest parity condition (UIP)

$$\Rightarrow E \cdot R_\$ = E \cdot R_€ + E^e - E$$

$$\Rightarrow E(1 + R_\$ - R_€) = E^e$$

$$\Rightarrow E = \frac{E^e}{1 + R_\$ - R_€}$$

→ The equilibrium exchange rate

$$\left(= E^e(1 + R_\$ - R_€)^{-1}\right)$$

How does the exchange rate depend on the exogenous variables?

$$\frac{\partial E}{\partial E^e} = \frac{1}{1+R_\$-R_€} > 0$$

Higher expected exchange rate
⇒ Higher exchange rate (depreciation)

$$\frac{\partial E}{\partial R_\$} = -E^e(1+R_\$-R_€)^{-2} = -\frac{E^e}{(1+R_\$-R_€)^2} < 0$$

Higher dollar interest rate
⇒ Lower exchange rate / strengthening of dollar (appreciation)

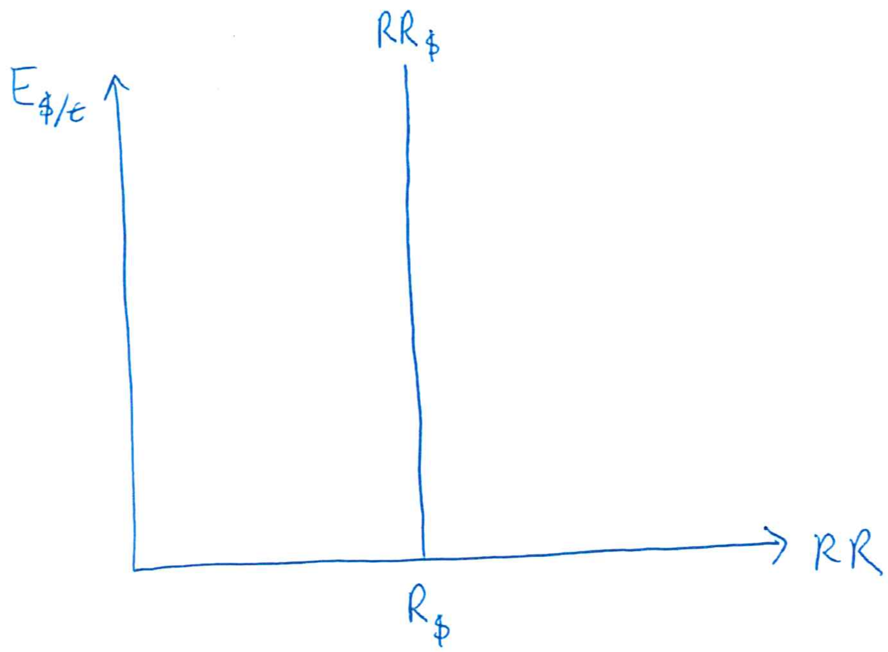
$$\frac{\partial E}{\partial R_€} = -E^e(1+R_\$-R_€)^{-2} \cdot (-1) = \frac{E^e}{(1+R_\$-R_€)^2} > 0$$

Higher euro interest rate
⇒ Higher exchange rate / weakening of dollar (depreciation)

Graphical solution:

- Rate of return on dollar deposits:

$$RR_\$ = R_\$$$



- Rate of return on euro deposits:

$$RR_€ = R_€ + \frac{E^e - E}{E}$$

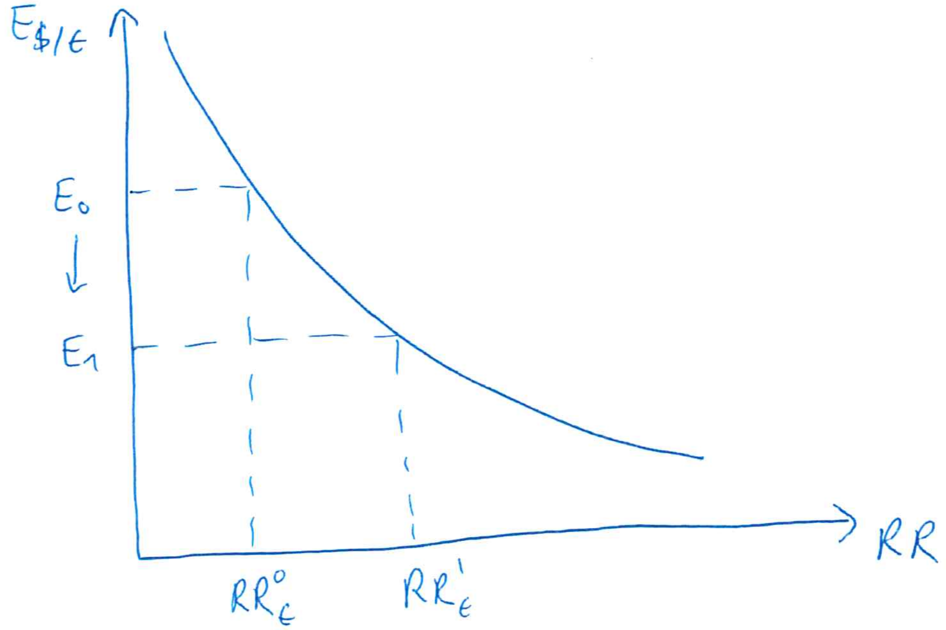
$$\frac{\partial RR_€}{\partial E} = \frac{-1 \cdot E - (E^e - E) \cdot 1}{E^2}$$

$$= \frac{-E - E^e + E}{E^2}$$

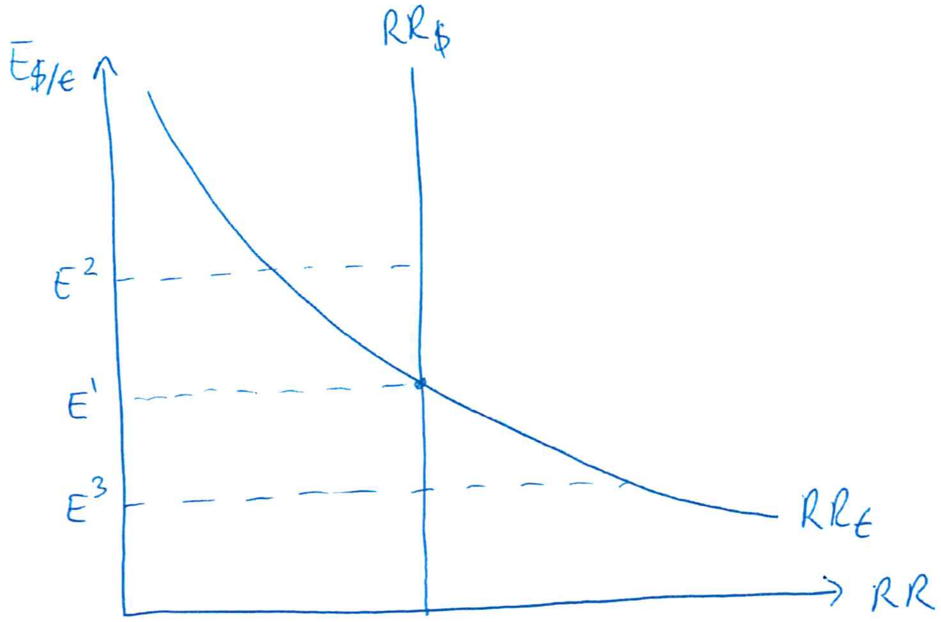
$$= -\frac{E^e}{E^2} < 0 \qquad \text{Falling curve}$$

$$\frac{\partial^2 RR_€}{\partial E^2} = -(-2)\,E^e E^{-3}$$

$$= \frac{2E^e}{E^3} > 0 \qquad \text{Convex curve}$$



Equilibrium:



Equilibrium exchange rate is E^1.

If $E > E^1$, ex E^2 : $RR_\$ > RR_€$

$\Rightarrow$ Demand for dollar deposits goes up

$\Rightarrow E_{\$/€} \downarrow$

Continues until $E = E^1$ and $RR_\$ = RR_€$

If $E < E^1$, ex E^3 : $RR_\$ < RR_€$

$\Rightarrow$ Supply of dollar deposits goes up

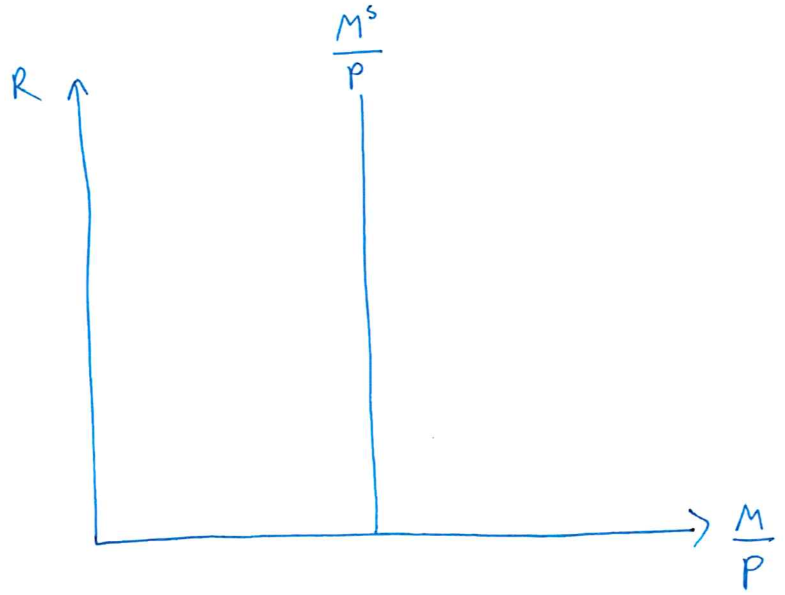
$\Rightarrow E_{\$/€} \uparrow$

Continues until $E = E^1$ and $RR_\$ = RR_€$

The money market

Money supply, M^s

→ Determined by the central bank



M = stock of money

P = price level

Money demand, M^d

Influenced by the interest rate (R), the price level (P) and real national income (Y):

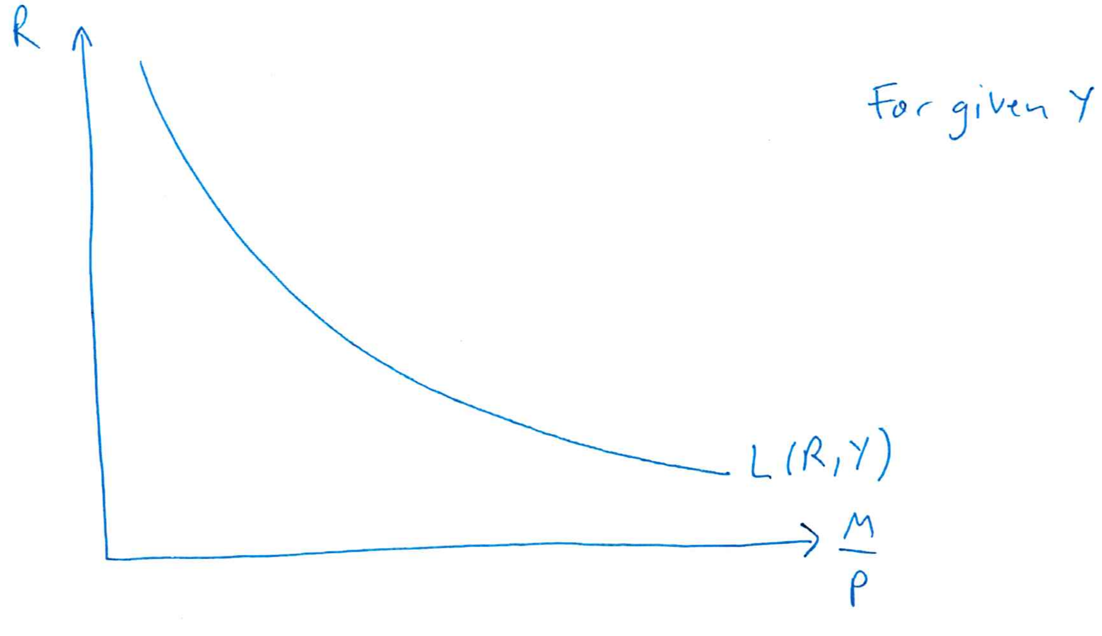
$$M^d = P \cdot L(R, Y)$$

$$\Rightarrow \frac{M^d}{P} = L(\underset{-}{R}, \underset{+}{Y})$$

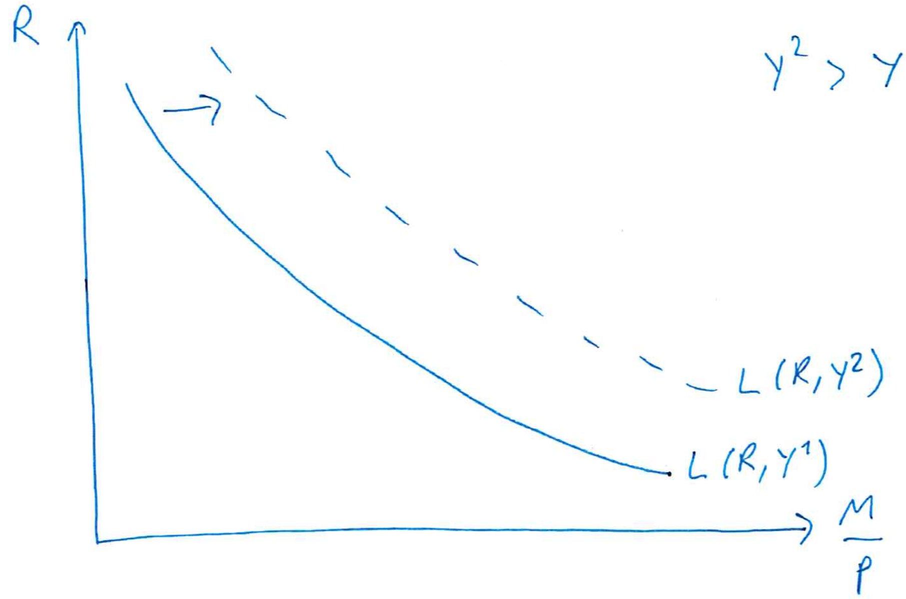
$\frac{\partial M^d}{\partial R} < 0$: Higher interest rate $\Rightarrow$ Lower money demand

$\frac{\partial M^d}{\partial Y} > 0$: Higher GNP $\Rightarrow$ More transactions $\Rightarrow$ Higher money demand

$\frac{\partial M^d}{\partial P} > 0$: Higher prices $\Rightarrow$ Higher money demand



Effect of increased income on M^d:



For a given interest rate, higher income implies higher demand for money

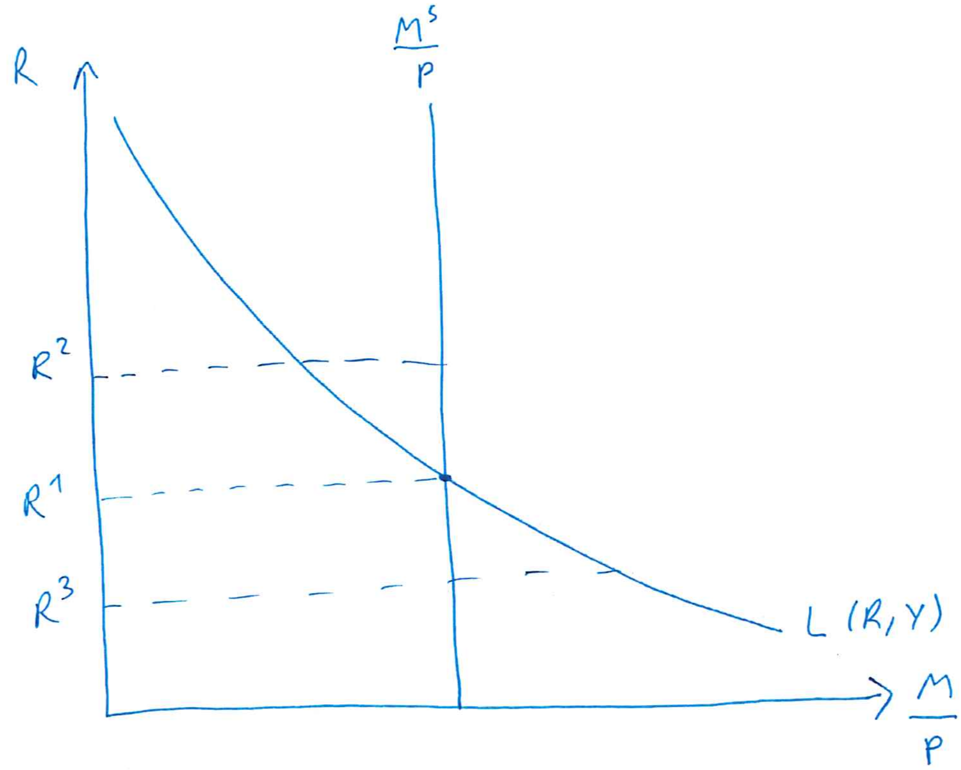
→ The curve shifts to the right.

Equilibrium in the money market

$$M^s = M^d$$

$$\Rightarrow M^s = P \cdot L(R, Y)$$

$$\Rightarrow \frac{M^s}{P} = L(R, Y)$$ → determines the interest rate for given values of M^s, P and Y



R^1 = equilibrium interest rate

$R > R^1$, ex $R = R^2$: Money supply > Money demand

$\Rightarrow$ Higher demand for bonds

$\Rightarrow$ Higher price on bonds

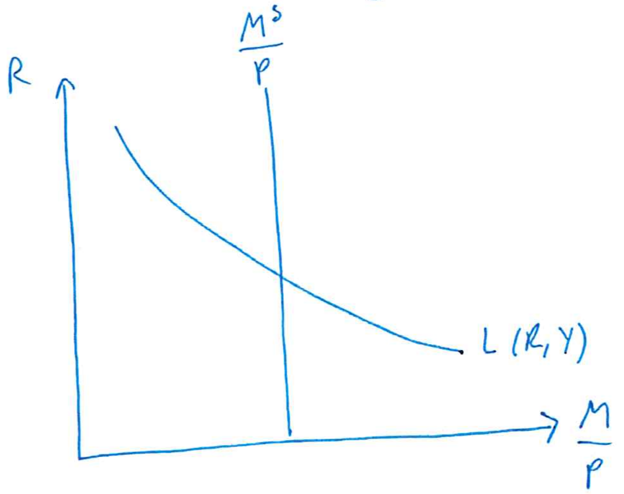
$\Rightarrow$ Lower return, $R \downarrow$

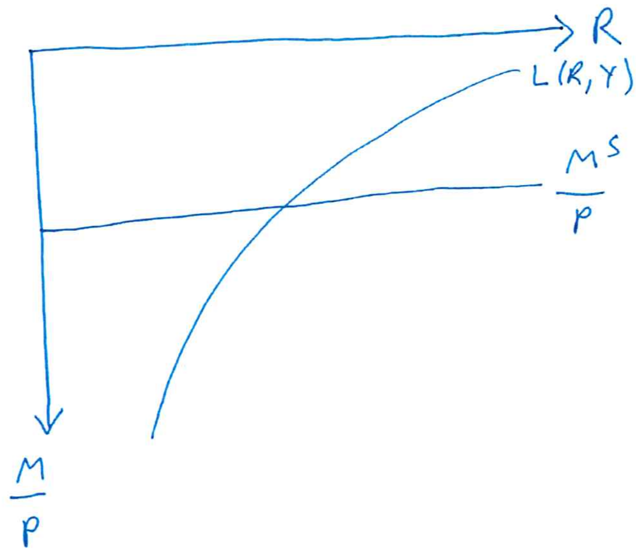
(see footnote 4, page 422)

Opposite when $R < R^1$.

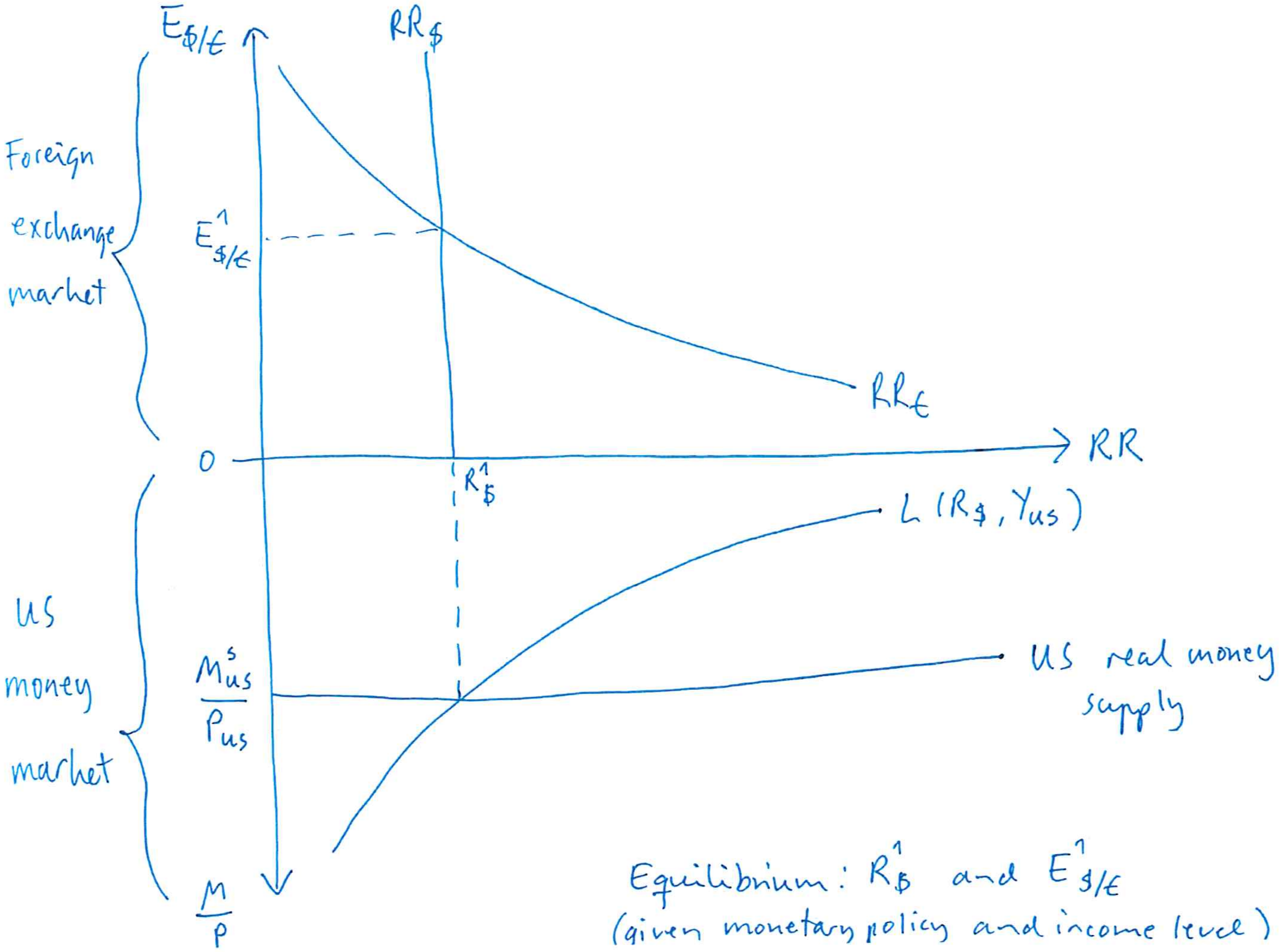
Combining the money market and the foreign exchange market

Rotate the money market figure:





Money market + Forex market:



Equilibrium: $R^1_\$$ and $E^1_{\$/€}$
(given monetary policy and income level)

Asset market equilibrium: The AA schedule

The AA schedule shows all combinations of output and the exchange rate where the domestic money market and the foreign exchange market are in equilibrium.

The money market equilibrium:

$$\frac{M^S}{P} = L(R, Y) \qquad (2)$$

The foreign exchange market equilibrium:

$$R = R^* + \frac{E^e - E}{E} \qquad (3)$$

M^S = money supply

P = domestic price level

R = domestic interest rate

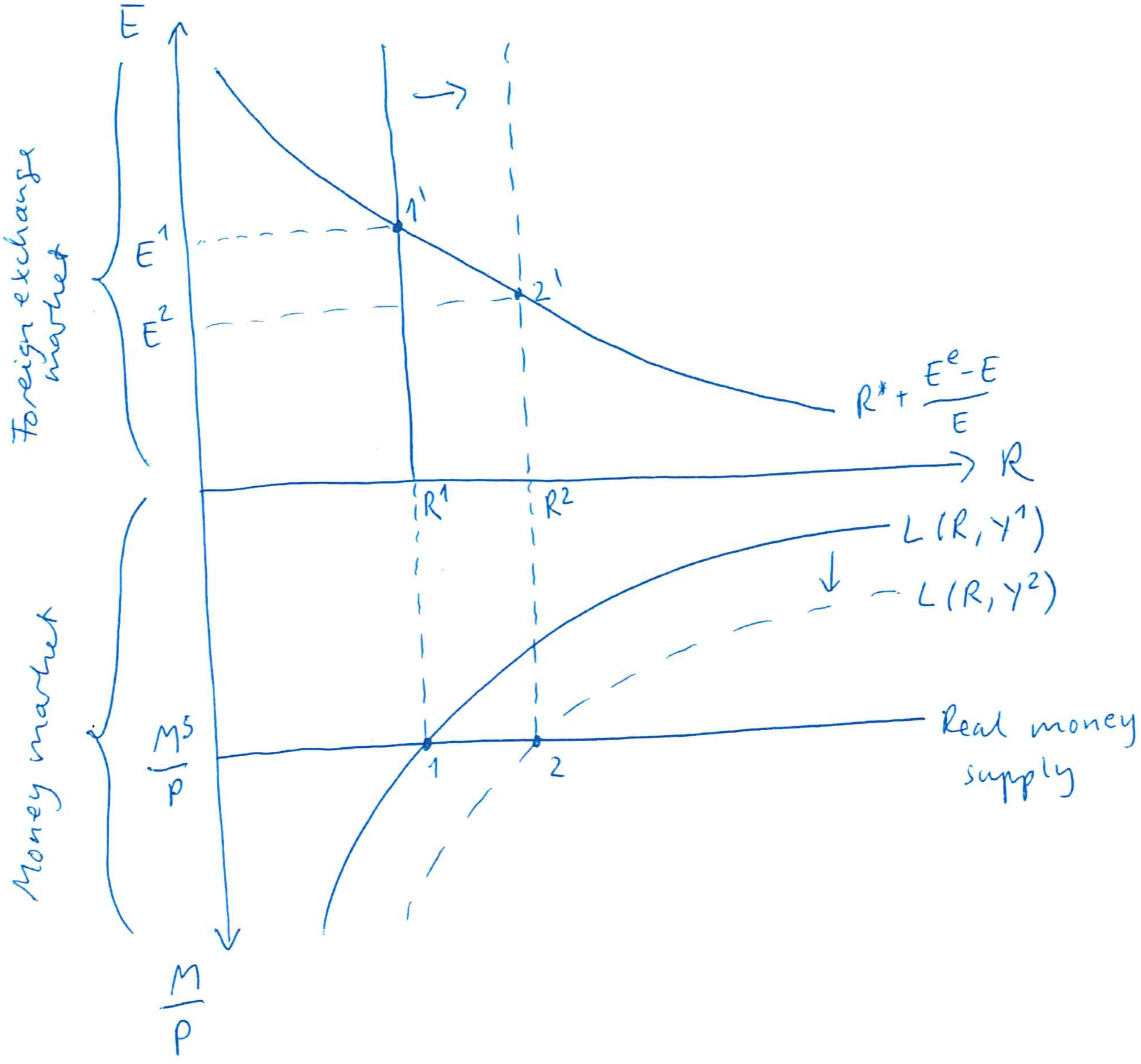
R^* = foreign interest rate

Y = output

E = exchange rate

E^e = expected exchange rate

Deriving the AA schedule graphically:



We start in points 1 and 1' with $Y = Y^1$ and $E = E^1$.

What happens to the exchange rate as income increases from Y^1 to Y^2?

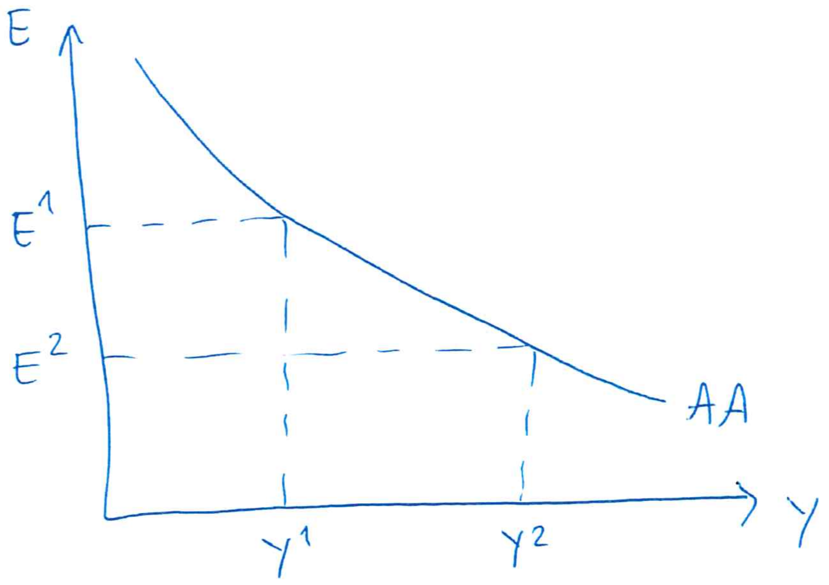
The money demand curve shifts down

$\Rightarrow$ The interest rate increases, $R^1 \rightarrow R^2$

$\Rightarrow$ The exchange rate appreciates ($E\downarrow$), $E^1 \rightarrow E^2$

New equilibrium in points 2 and 2'.

The AA schedule is therefore downward sloping:



Mechanism:

$Y\uparrow \Rightarrow M^d\uparrow \Rightarrow R\uparrow \Rightarrow E\downarrow$

Analytically:

Differentiate equation (2) with respect to R and Y:

$$\frac{M^s}{P} = L(R, Y)$$

$$\Rightarrow 0 = L_R \, dR + L_Y \, dY$$

$$\Rightarrow dR = -\frac{L_Y}{L_R} \, dY \qquad (Y\uparrow \Rightarrow R\uparrow)$$

where $L_R = \frac{\partial L}{\partial R} < 0$ and $L_Y = \frac{\partial L}{\partial Y} > 0$

Differentiate equation (3) with respect to R and E:

$$R = R^* + \frac{E^e - E}{E}$$

$$\frac{\partial \left(\frac{E^e - E}{E}\right)}{\partial E}$$

$$dR = \left(\frac{-1 \cdot E - 1 \cdot (E^e - E)}{E^2}\right) \cdot dE$$

$$\Rightarrow dR = -\frac{E^e}{E^2}\, dE \qquad (R\uparrow \Rightarrow E\downarrow)$$

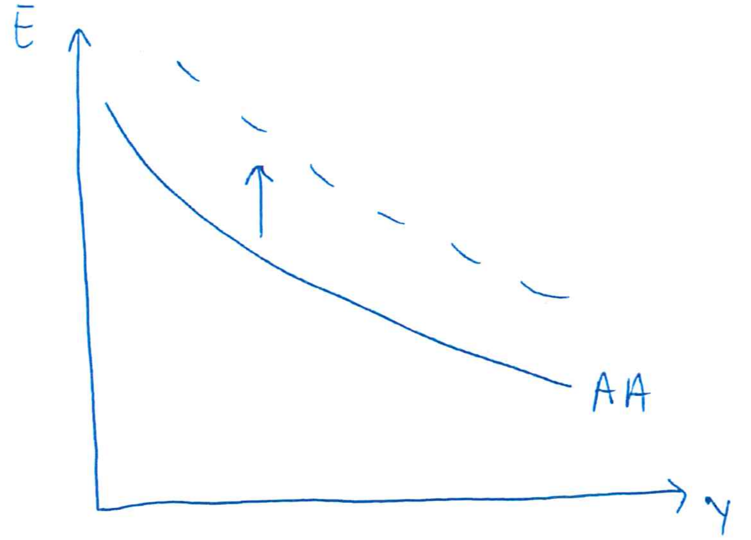
Combining the two equations:

$$\left.\begin{aligned} dR &= -\frac{L_Y}{L_R}\, dY \\ dR &= -\frac{E^e}{E^2}\, dE \end{aligned}\right\} \Rightarrow -\frac{E^e}{E^2}\, dE = -\frac{L_Y}{L_R}\, dY$$

$$\Rightarrow \frac{dE}{dY} = \frac{L_Y}{L_R} \cdot \frac{E^2}{E^e} < 0$$

Shifts in the AA schedule:

→ Changes in M^s, P, E^e or R^*



Upward shift:

$M^s\uparrow$, $P\downarrow$, $E^e\uparrow$, $R^*\uparrow$

Also:

- changes in money demand not related to Y

Summing up the AA-DD model:

(1) $Y = C(Y-T) + I + G + CA\left(\frac{EP^*}{P}, Y-T\right)$

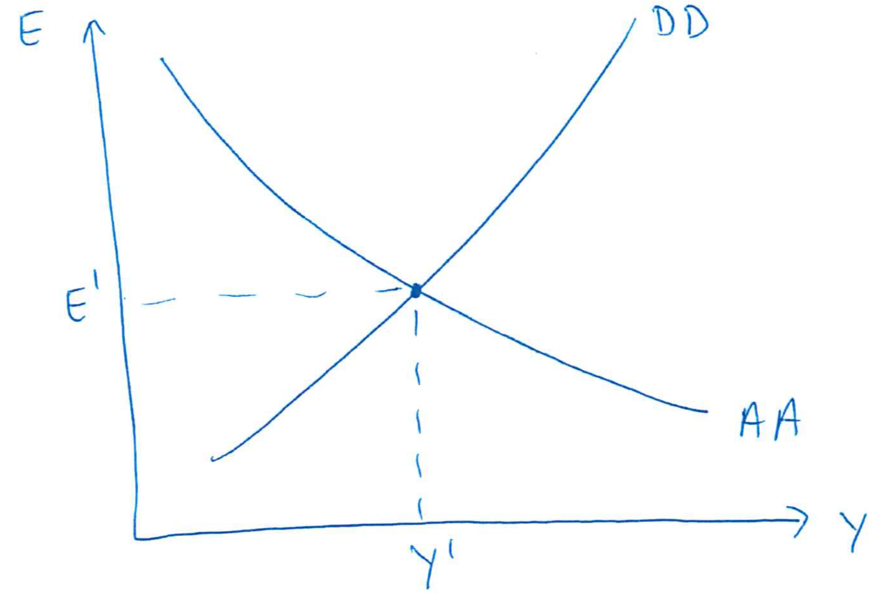
(2) $\frac{M^s}{P} = L(R, Y)$

(3) $R = R^* + \frac{E^e - E}{E}$

Three equations and three endogenous variables: Y, R, E

Exogenous variables: $T, I, G, P^*, P, M^s, R^*, E^e$

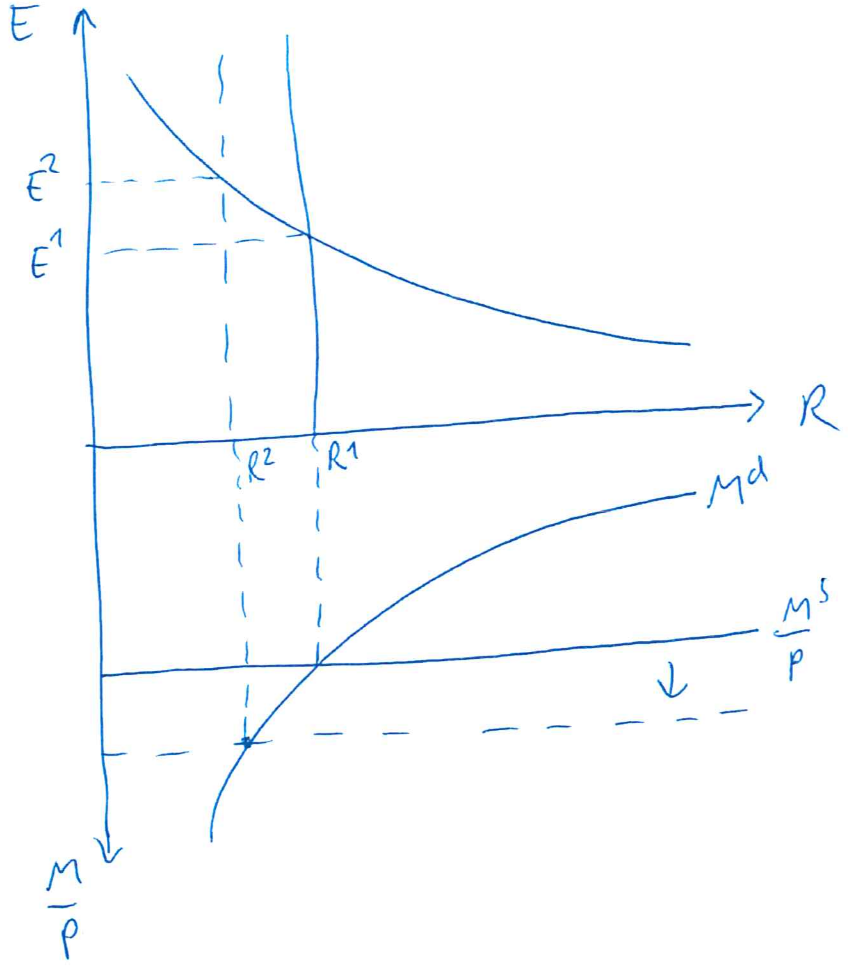
Equilibrium:



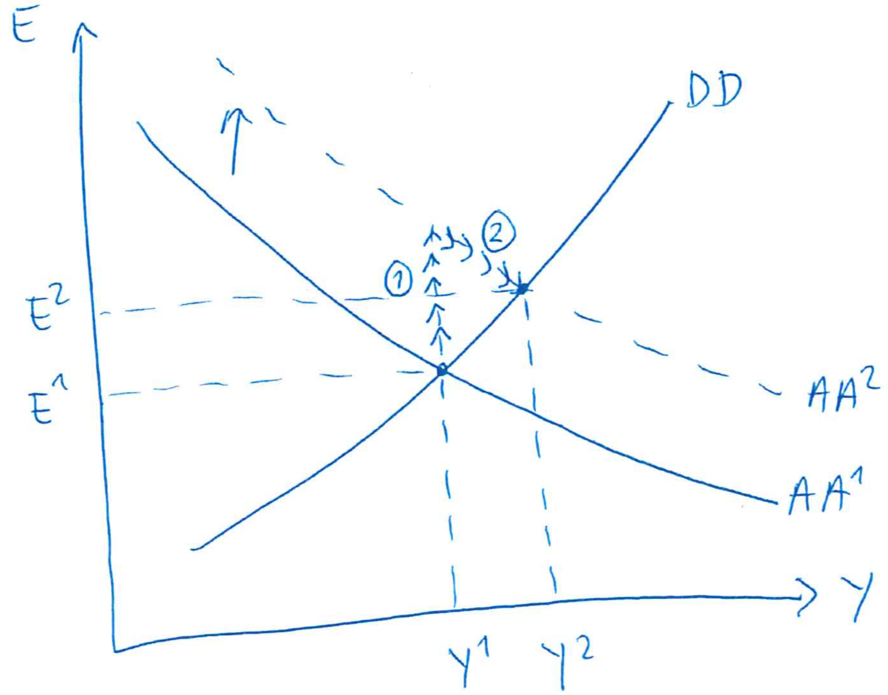
Temporary changes in monetary and fiscal policy

Expansionary monetary policy, $M^s \uparrow$

→ The AA schedule shifts upward (Higher E for given Y)



Showing why $M^s \uparrow$ will give an upward shift in the AA schedule



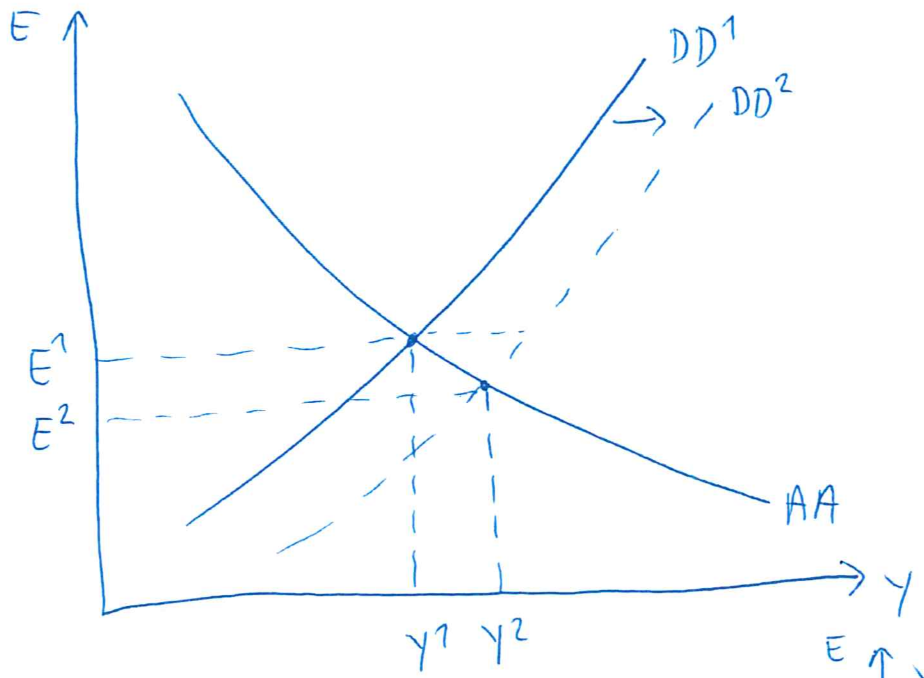
① $M^s \uparrow \Rightarrow R \downarrow \Rightarrow E \uparrow$

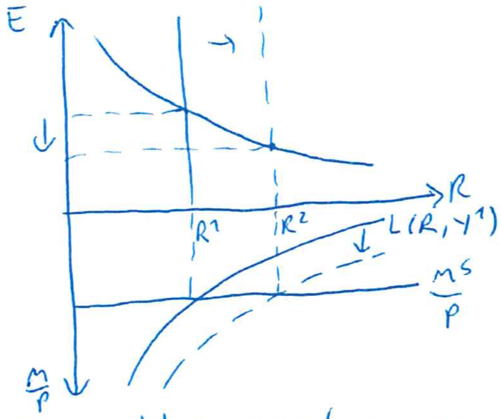
② $E \uparrow \Rightarrow CA \uparrow \Rightarrow Y \uparrow$

New equilibrium: Depreciation ($E^2 > E^1$) and higher output ($Y^2 > Y^1$)

Expansionary fiscal policy, $G\uparrow$

→ The DD schedule shifts to the right





$G\uparrow \Rightarrow Y\uparrow$

$Y\uparrow \Rightarrow M^d\uparrow \Rightarrow R\uparrow \Rightarrow E\downarrow$

Since E^e and R^* are unchanged, the exchange rate must appreciate for the uncovered interest parity condition to hold, $E\downarrow$

$E\downarrow \Rightarrow CA\downarrow \Rightarrow Y\downarrow$: The exchange rate appreciation reduces the expansion in output

New equilibrium: Appreciation ($E^2 < E^1$) and higher output ($Y^2 > Y^1$)

Summing up:

- Expansionary monetary policy implies currency depreciation that strengthens the current account
- Expansionary fiscal policy implies currency appreciation that weakens the current account