# Part IIA

# Supervision 8 - International Economics I

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# This Class

- A1. Uncovered Interest Parity (UIP) and the Asset Approach to Exchange Rates.
- B1. Exchange Rate Overshooting in the DD-AA Model (Graphs).
- B2. Exchange Rate Overshooting in the DD-AA Model (Maths).

# Short Questions

# Question A1 - Set Up

- *A1. Consider a simple asset market model of the exchange rate in which the foreign exchange market is described by*

$$(1 + i_t) = (1 + i_t^*)\frac{\mathbb{E}[e_{t+1}]}{e_t},$$

*where $i_t$ is the UK interest rate, $i_t^*$ is the US interest rate, and $e_t$ is the spot exchange rate (defined as pounds per dollar) at time $t$. Money market equilibrium in the UK is given by*

$$\frac{M_t}{P_t} = L(i_t, Y),$$

*where $M_t$ is money supply, $P_t$ is the aggregate price level and $Y_t$ is the aggregate level of output in the UK at time $t$. Money demand $L(\cdot)$ satisfies $\partial L/\partial i < 0$ and $\partial L/\partial Y > 0$. Assume that for each period $t$, output equals its natural rate $Y_t = \bar{Y}$ and the price level, $P_t$ is preset in period $t-1$. Purchasing power parity is assumed to hold in the long run.*

# Question A1 - Question (Perm $\downarrow$ in Money Supply)

- *Suppose the Bank of England suddenly announces at the beginning of period* $t = 1$ *that it will implement a permanent decrease in the level of the money supply,* $M$ *by* $x\%$ *in period* $t = 2$.

- *Show graphically and explain intuitively how this affects the exchange rate* $e_t$ *in periods 1 and 2. What is the percentage change in* $e_t$ *in each period.*

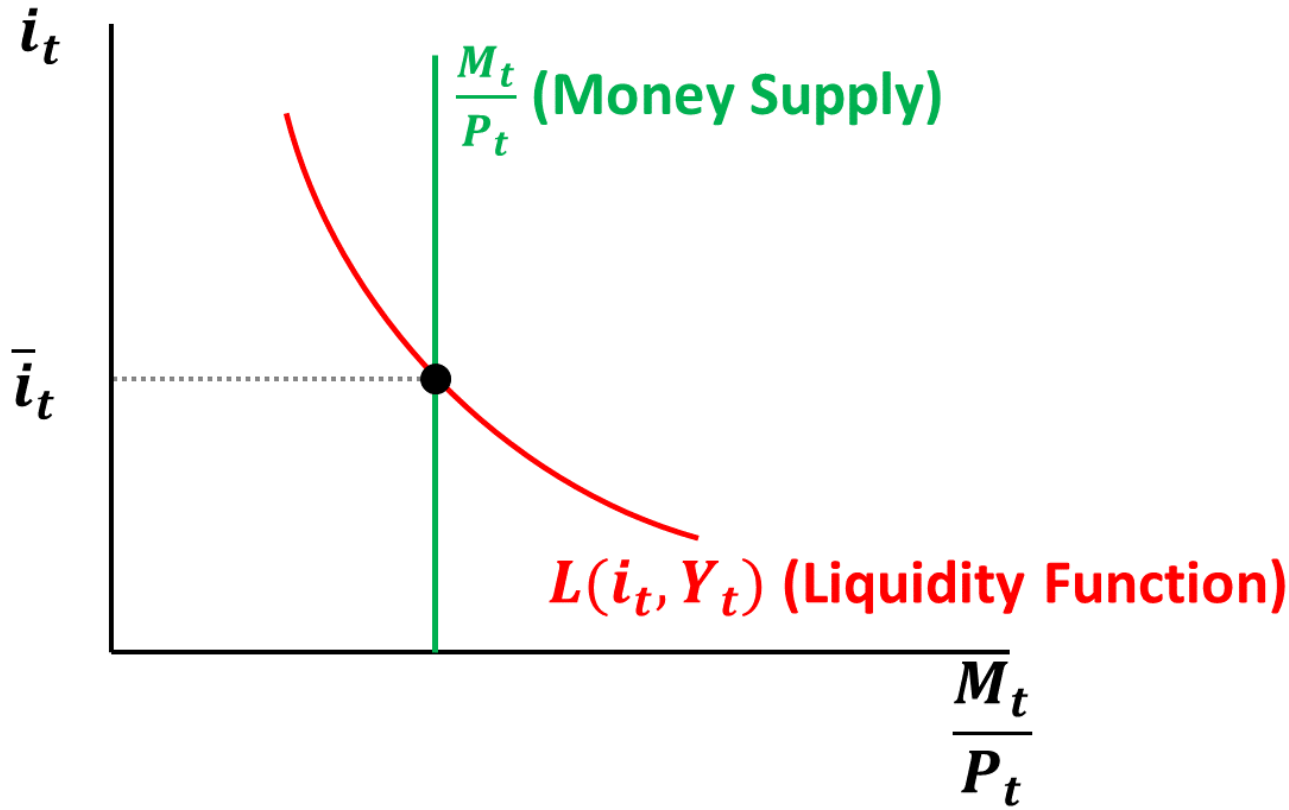
# Question A1 - Short Answer

- At $t = 1$ when policy announced, UIP curve **shifts down**.
- Currency **appreciates** ($\hat{e} = -x\%$) in anticipation of future policy change.
- **No further change** occurs in period $t = 2$.

# Question A1 - Graphical Answer I

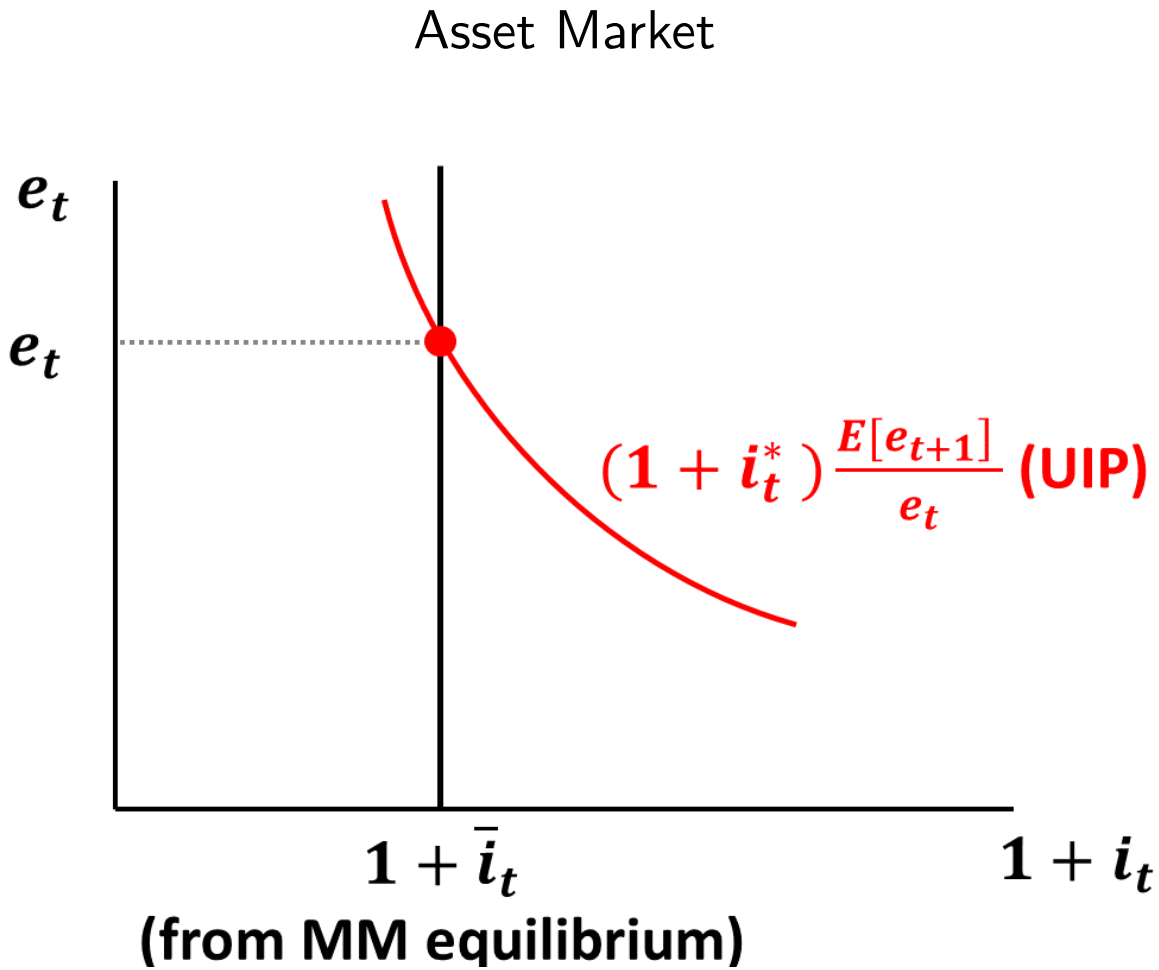
- No change in money market today, as permanent reduction in money supply arises tomorrow.

Money Market



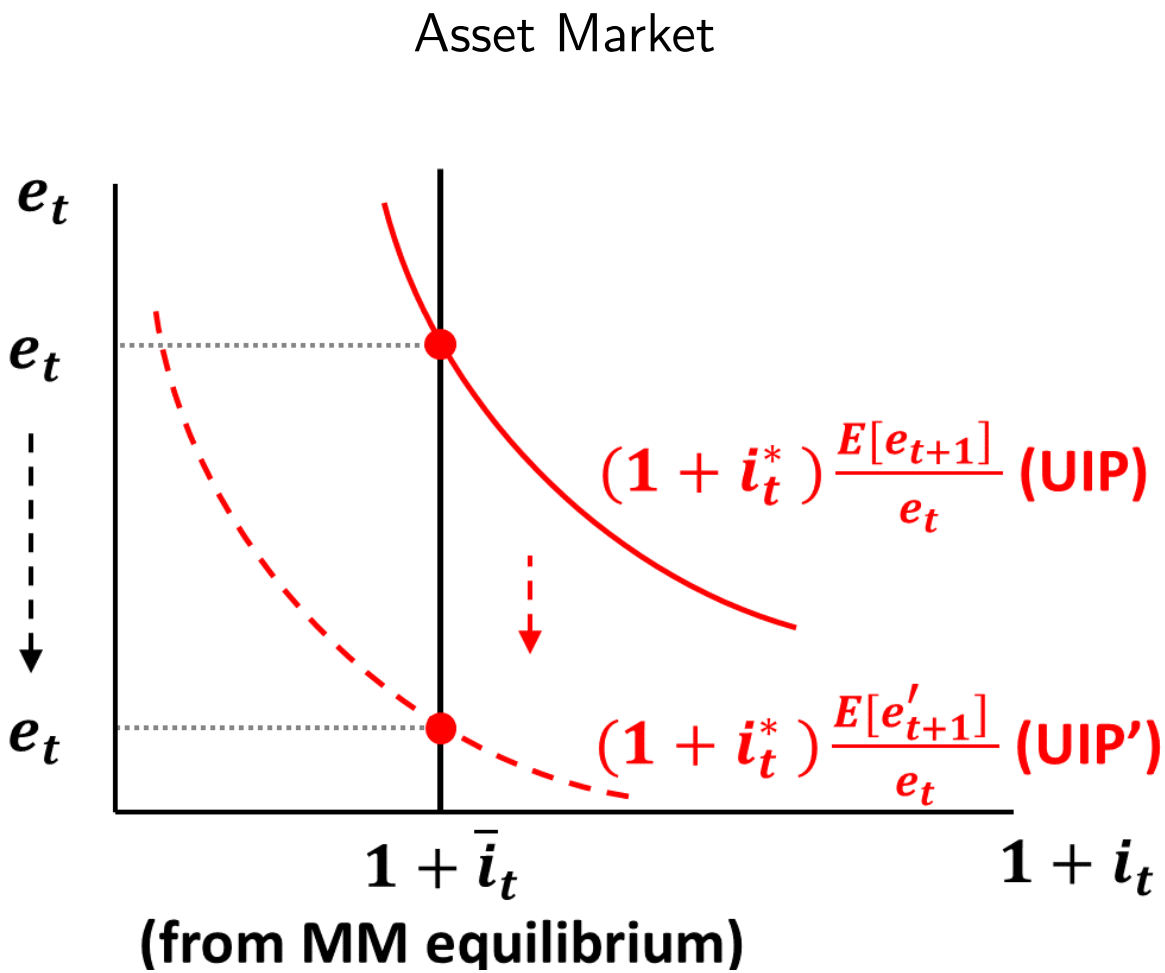
# Question A1 - Graphical Answer II

- Initial position of UIP curve is unsustainable, as in long run nominal variables move together $\hat{M} = \hat{P} = \hat{e} = -x\%$.



# Question A1 - Graphical Answer III

- Therefore UIP curve **shifts down** and the exchange rate **appreciates**.



# Question A1 - Longer Answer I

- We will find the solution through **backward induction**.

- **Recap**. Model says, assuming we know the exogenous values: $i_t^*$, $E[e_{t+1}]$, $P_t$ and $Y_t$, and given the exogenous policy variable $M_t$ we may calculate $i_t$ and $e_t$ through equilibrium in the money market and foreign exchange market.

- Let us first clarify the **timing** of the model:

  1. $i_t^*$, $P_t$ and $Y_t$ are already set;

  2. $M_t$ and $M_{t+1}$ are announced, $i_t$ and $e_t$ are determined. $P_{t+1}$ is set;

  3. $M_{t+1}$, $i_{t+1}$, $e_{t+1}$ and $P_{t+1}$ are realised.

# Question A1 - Longer Answer II

- Begin in period $t+1$.

- In the long run, purchasing power parity and the quantity theory of money imply:

$$\hat{M} = \hat{P} = \hat{e} = -x\%,$$

  where "hatted" variables refer to proportional changes.

- Thus, in period $t+1$, the level of real money balances, $M/P$, is **the same** as previously.

- As the economy is operating at its natural rate of output, the nominal interest rate must also be **unchanged** from the prior equilibrium, i.e. $\hat{i} = 0$.

# Question A1 - Longer Answer III

- Turning to the current period, $t$.
- The money market equilibrium is again **unchanged** when the policy is announced.
- In the asset market, as $\mathbb{E}[e_{t+1}] \downarrow$, the UIP curve will shift **downwards**.
- This implies that the exchange rate will **appreciate today**, as anticipation of future appreciation makes it more attractive to invest in domestic currency deposits: $\mathbb{E}[\hat{e}] = -x\%$.

# Question A1 - Final Comments

- To reiterate, in period $t+1$, there is **no further change** in the exchange rate, as the policy is already "priced in" during period $t$.
- In both period $t$ and $t+1$, there is **no change** in real money balances.
  - In period $t$, $M_t$ has not been changed and $P_t$ is preset.
  - In period $t+1$, both variables change by an equiproportional amount, meaning that their ratio is invariant.

# Long Questions

# Question B1 - Recap of AA-DD Model I

- Three markets: (1) Goods; (2) Money; (3) FX.
- The equilibrium conditions for all markets may be written as:

$$P = \bar{P} \qquad \text{(Short Run)}$$

$$Y = \bar{Y} \quad \text{and} \quad \epsilon = f(D/D^*, Y/Y^*) \qquad \text{(Long Run)}$$

- AA curve describes simultaneous equilibrium in both asset markets (money and FX).
- DD curve describes goods market equilibrium (open economy Keynesian cross).

# Question B1 - Recap of AA-DD Model II

- A nominal exchange rate depreciation causes a real exchange rate depreciation (all else equal) due to sticky prices.
- Foreign goods are then more expensive.
- Consumers shift consumption towards Home products, and the current account improves. (**Expenditure switching effect**).
- A **depreciation** is therefore associated with an **expansion** of demand. More formally, this is due to the **Marshall-Lerner** condition $\frac{\partial CA}{\partial \epsilon} > 0$ iff $\eta + \eta^* > 1$, where $\eta$ ($\eta^*$) is the home (foreign) elasticity of output demand.

# Question B1 - Set Up

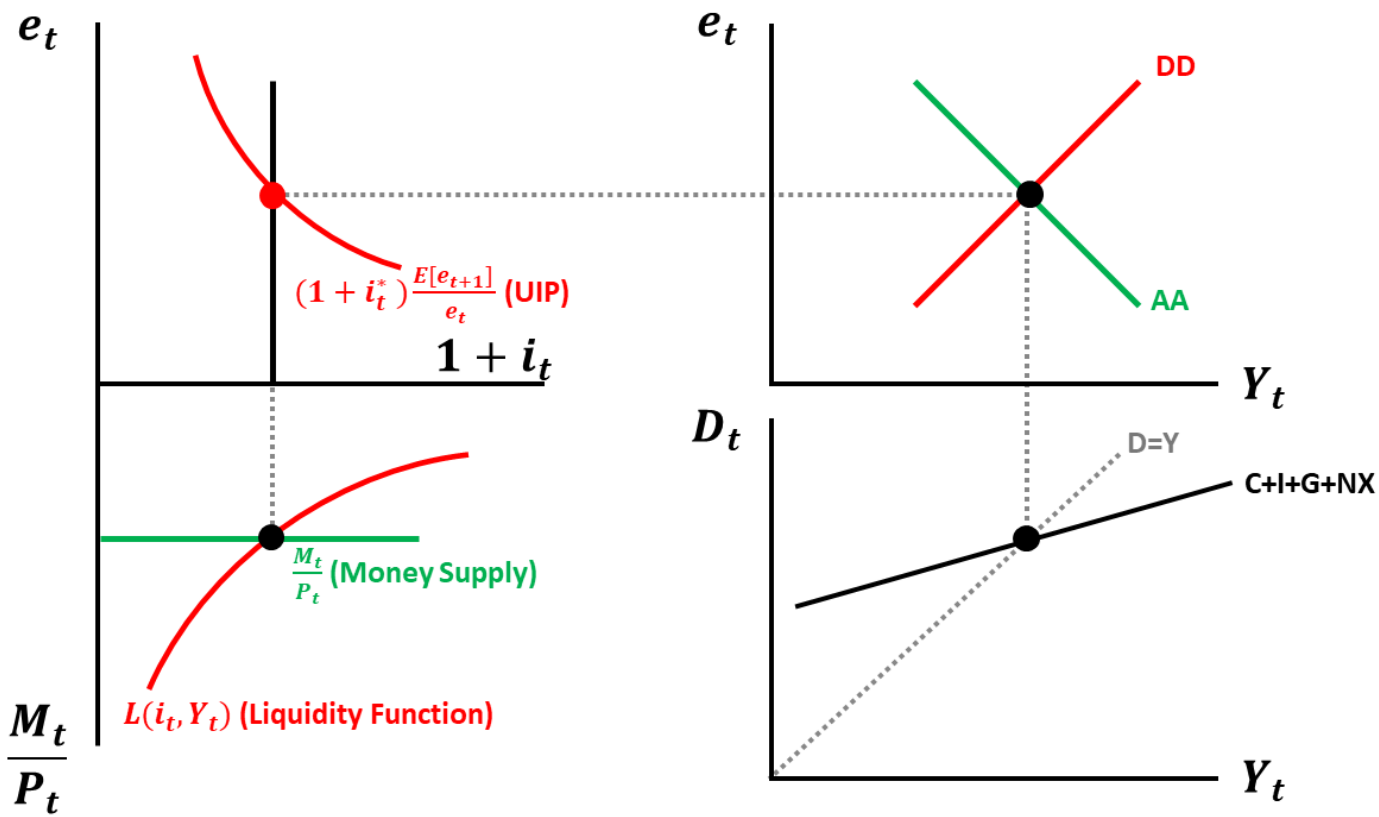
- *B1. This problem analyzes the circumstances under which an unanticipated, permanent monetary expansion produces exchange rate* **overshooting** *in the DD-AA model. Assume the economy is initially in long run equilibrium.*

- (a) *Suppose people expect that next year, there will be a permanent increase in the level of money supply by 100%. Show graphically the short run effect on the exchange rate and output. Give an intuitive explanation.*

# Question B1 - (a) Graphical I

- Equilibrium arises when (1) money, (2) foreign exchange and (3) goods markets clear simultaneously, determining $(Y, e_0)$.

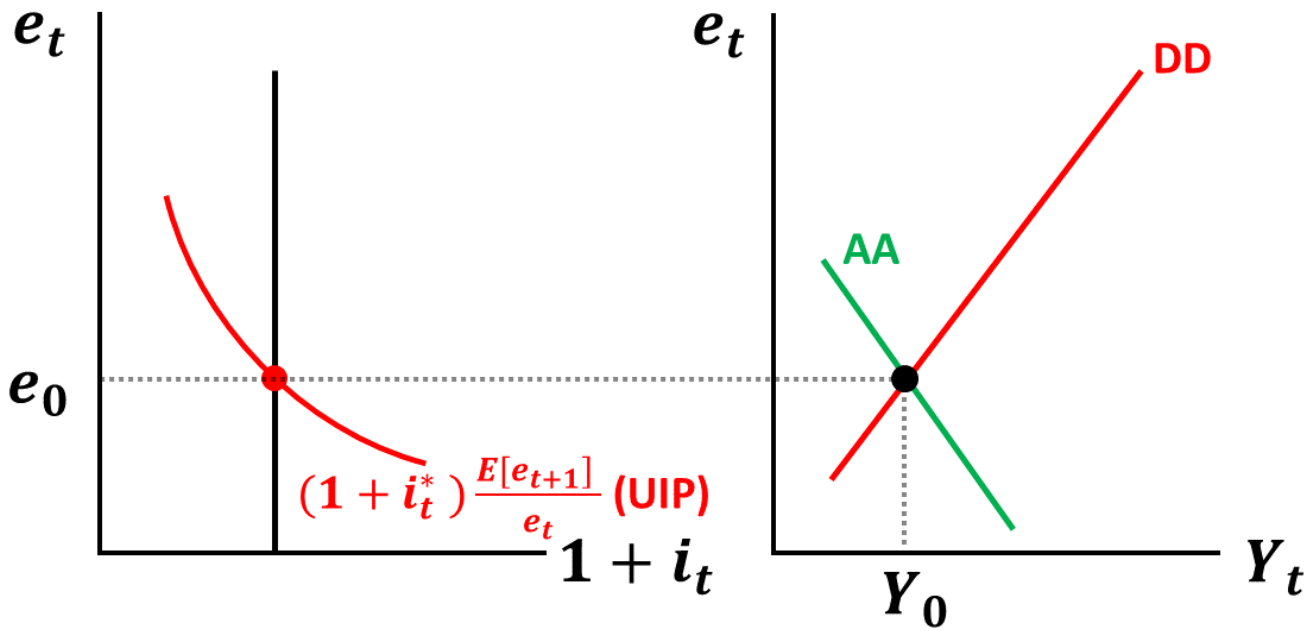
AA-DD Equilibrium



# Question B1 - (a) Graphical II

- We can **system reduce**, as no change in money market or goods market for a given $e_t$ (construction of DD).

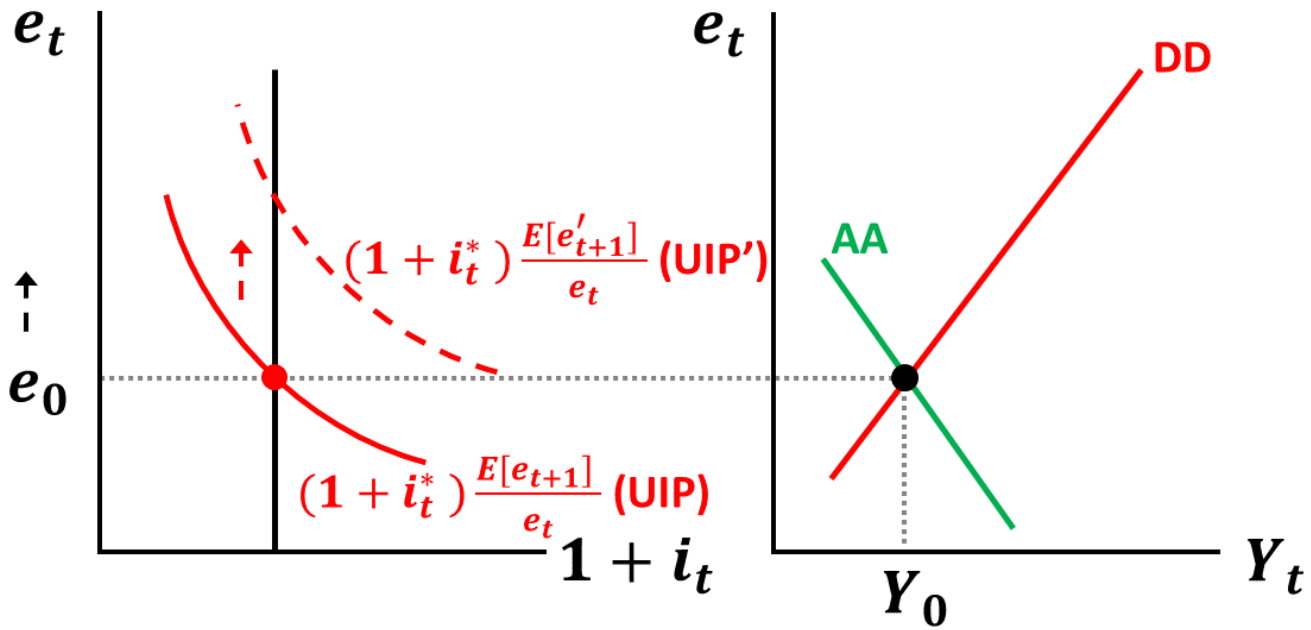
FX and Overall Equilibrium.



# Question B1 - (a) Graphical III

- In the long run, $\hat{M} = \hat{P} = \hat{e} = 100\%$. As $\mathbb{E}[e_{t+1}] \uparrow$, UIP curve will shift **upwards** (by $e_0$) due to expectations effect.
- The exchange rate will **depreciate today** in anticipation of future depreciation.

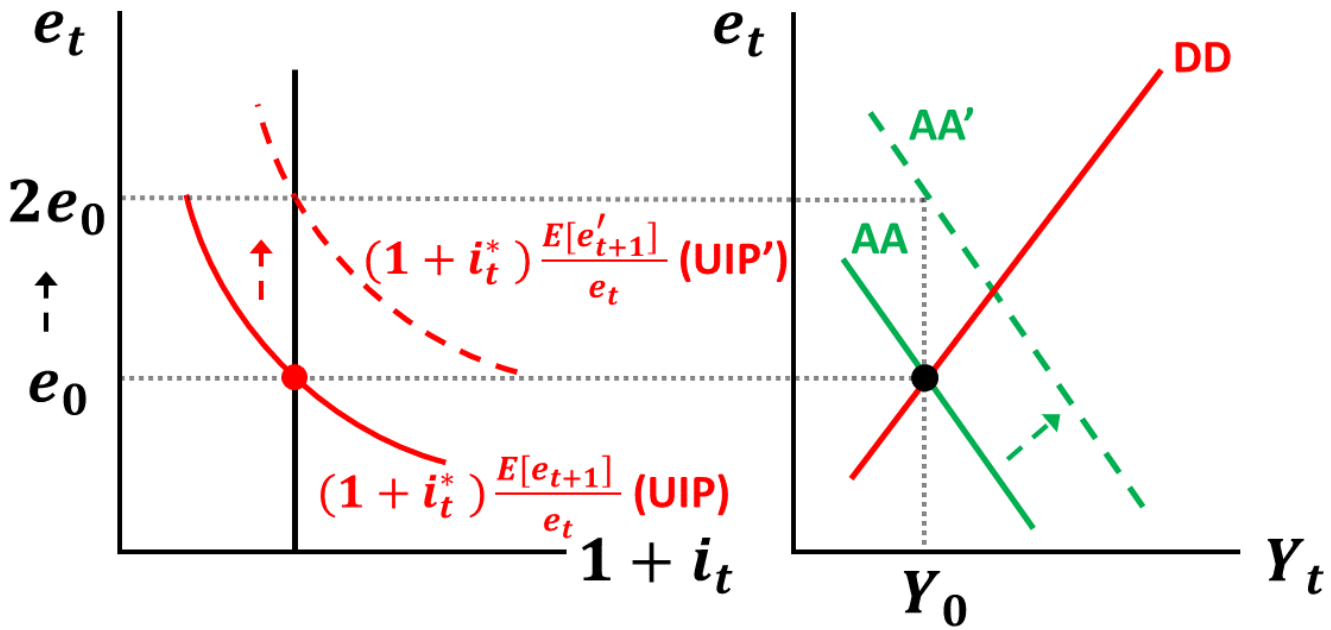
FX and Overall Equilibrium.



# Question B1 - (a) Graphical IV

- Thus the AA curve will also shift **outwards** (by $e_0$). Overall depreciation ($< 100\%$) and output expansion ($Y \uparrow$ and $e \uparrow$).
- Movement along the DD curve due to current account becoming more positive (Marshall-Lerner condition).

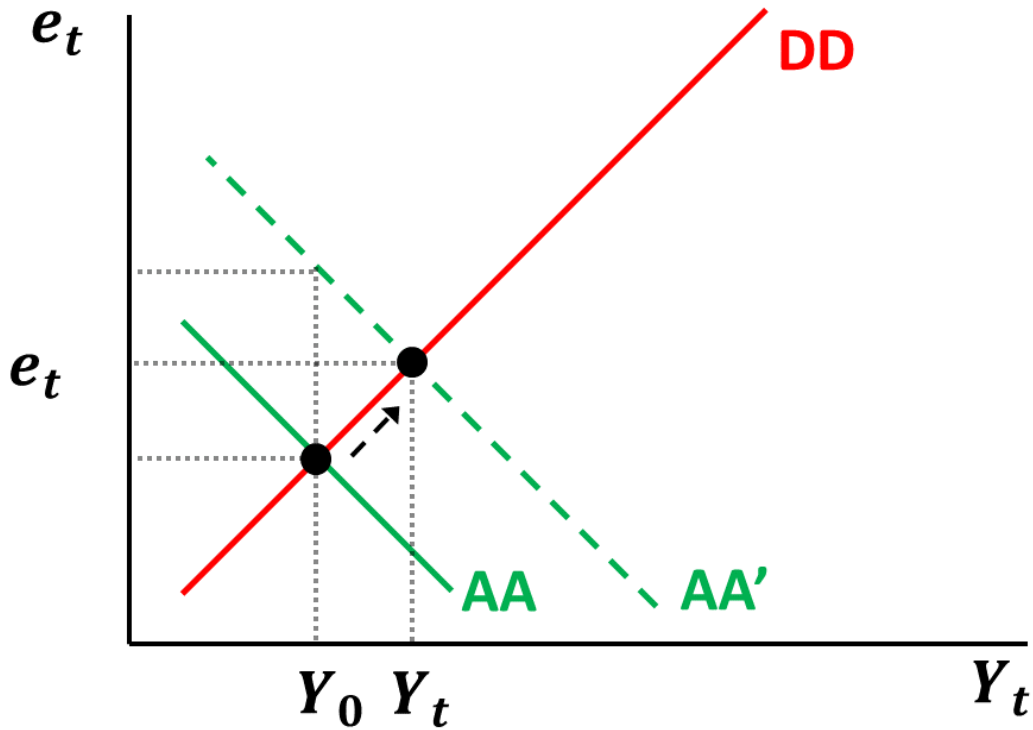
FX and Overall Equilibrium.



# Question B1 - (a) Graphical V

- To reiterate, short run movement is therefore along DD curve for equilibrium $(Y_t, e_t)$.

Overall Equilibrium.



# Question B1 - (a) Intuition

- In the long run, PPP holds, so $\hat{M} = \hat{P} = \hat{e}$, and hence, $E[e] \uparrow$.
- This increases gross return from foreign currency deposits, hence money flows out, immediate depreciation.
- AA curve shifts rightward (up) due to expectations effect.
- Given short-run sticky prices, the real exchange rate depreciates. This drives up output.
- Note that short-run increase in exchange rate less than 100%, the reason being that increase in output drives up demand for real money balances (transactions motive), pushing up the interest rate [in this LM environment], dampening the depreciation.

# Question B1 - (b) Question

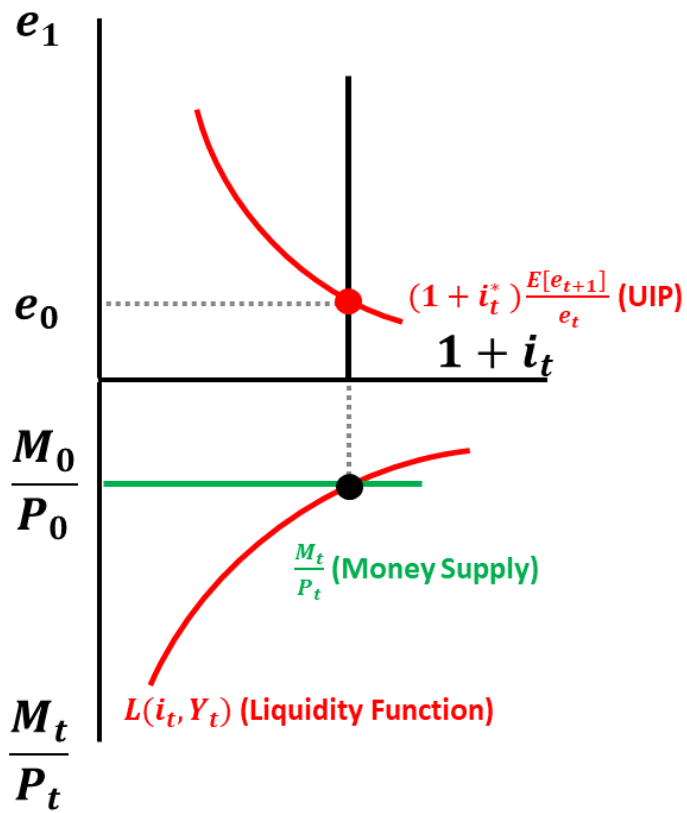
- (b) *Now, consider an unanticipated permanent increase in the level of money supply by* 100%. *Using the graph in (a), show the short run effect on the exchange rate and output and give an intuitive explanation. What will be the new long run equilibrium?*

- **Main point**: now the current money market also changes, but long run equilibrium is unchanged.

# Question B1 - (b) Graphical I

- Initially the Money and Foreign Exchange markets are as before.

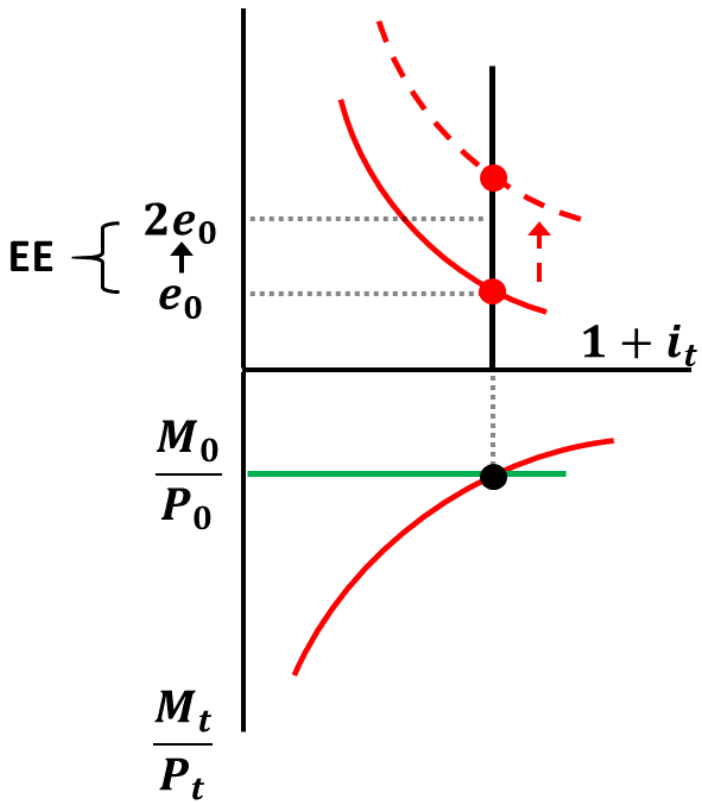
Money and FX Equilibrium.



# Question B1 - (b) Graphical II

- Announcement of a future monetary expansion produces an **Expectations Effect** (EE) as in part (a). UIP shifts **upwards**.

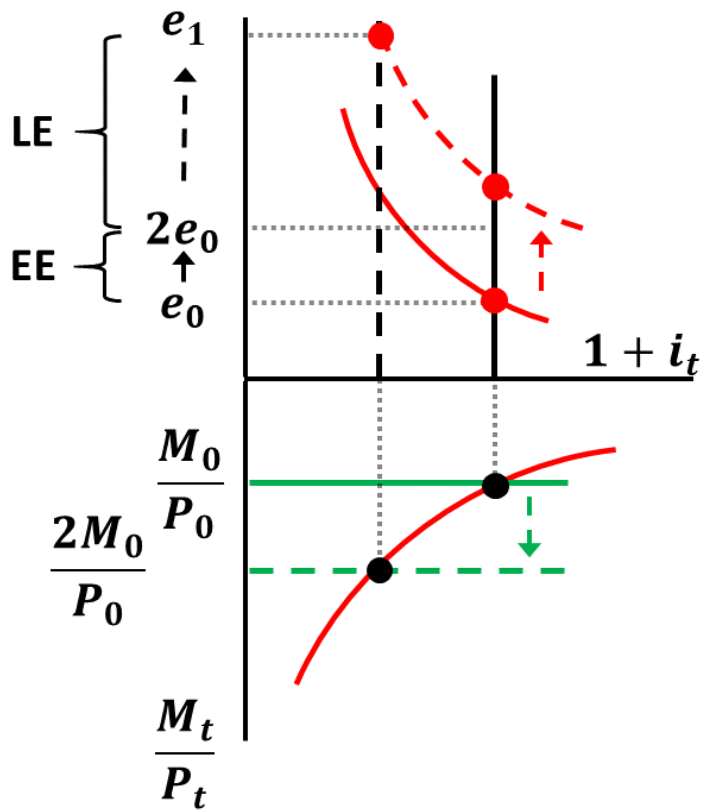
Money and FX Equilibrium.



# Question B1 - (b) Graphical III

- Current money supply change produces additional **Liquidity Effect** (LE) as move **along** UIP. Thus $e \uparrow$ **more** than in (a).

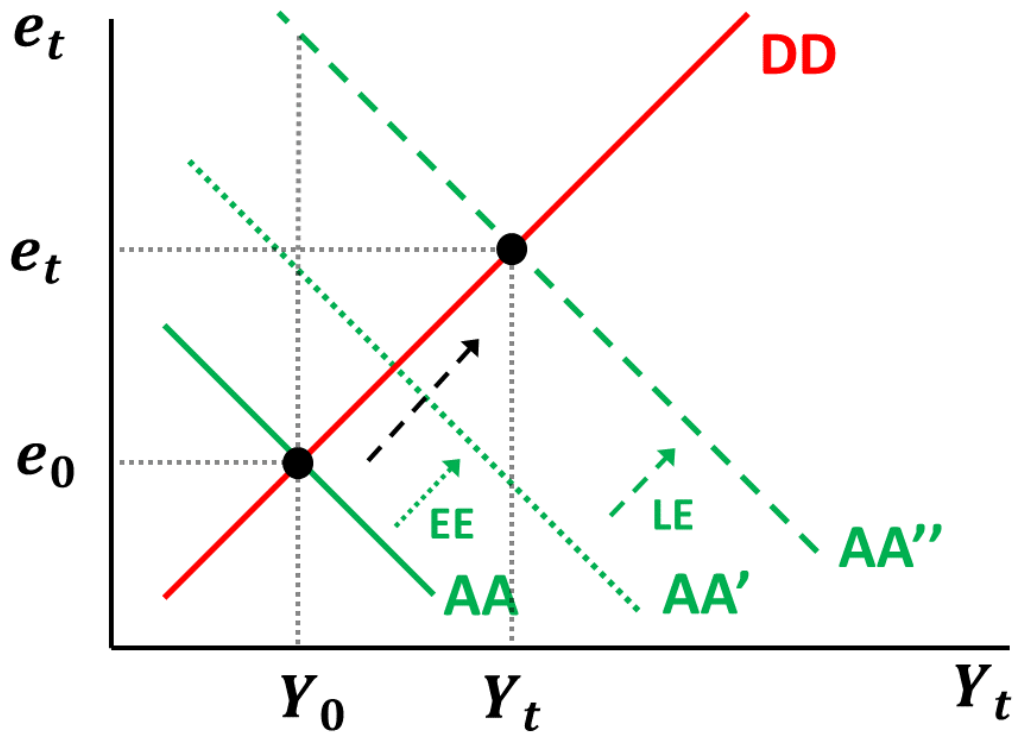
Equilibrium.



# Question B1 - (b) Graphical IV

- In AA-DD setting, AA therefore shifts **more** than in (a) due to Liquidity Effect (LE). ($Y \uparrow\uparrow$ and $e \uparrow\uparrow$).

Overall Equilibrium (Short Run).



# Question B1 - (c) Question

- (c) *Using the same graph, show the adjustment toward the new long run equilibrium after the unanticipated permanent increase in the level of money supply by* 100%. *Explain intuitively how the adjustment takes place.*

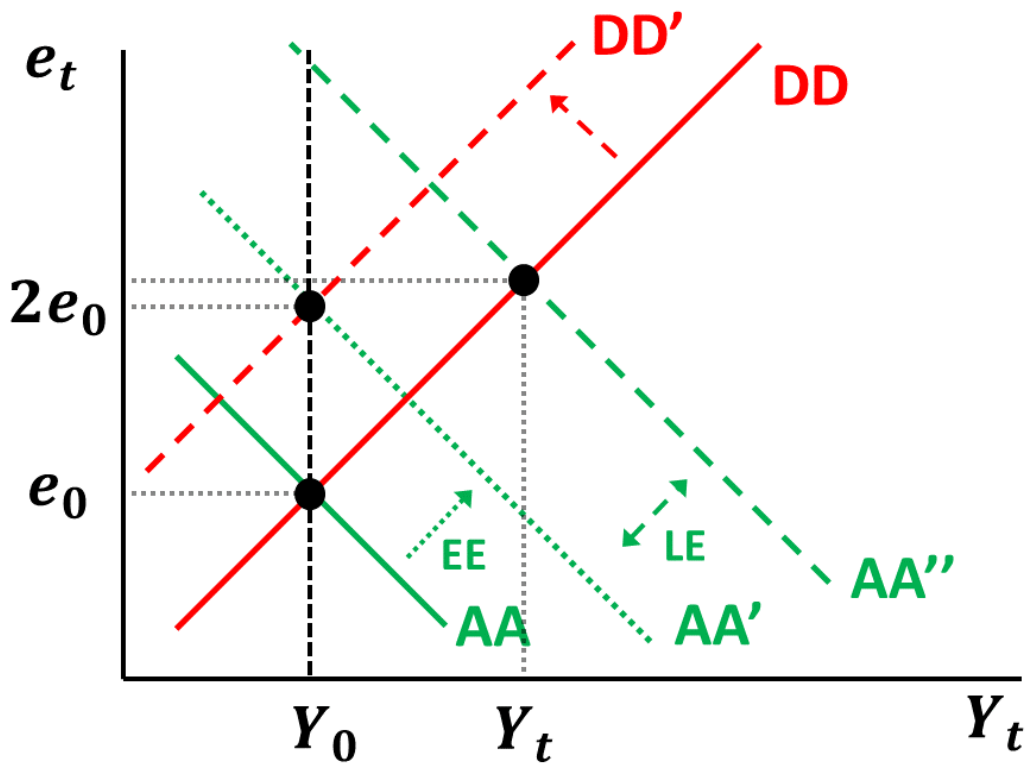
- **Main point**: The long run equilibrium in (a) is equal to that in (b). Transition to long run involves both AA and DD shifts.

# Question B1 - (c) Graphical I

- In LR $P \uparrow$ shifts AA down from AA'' to AA' as $\frac{M}{P} \downarrow$ (reversing liquidity effect). $P \uparrow$ shifts DD up as $\epsilon \downarrow$.

- Net effect during transition involves $Y \downarrow$ but $e$ ambiguous.

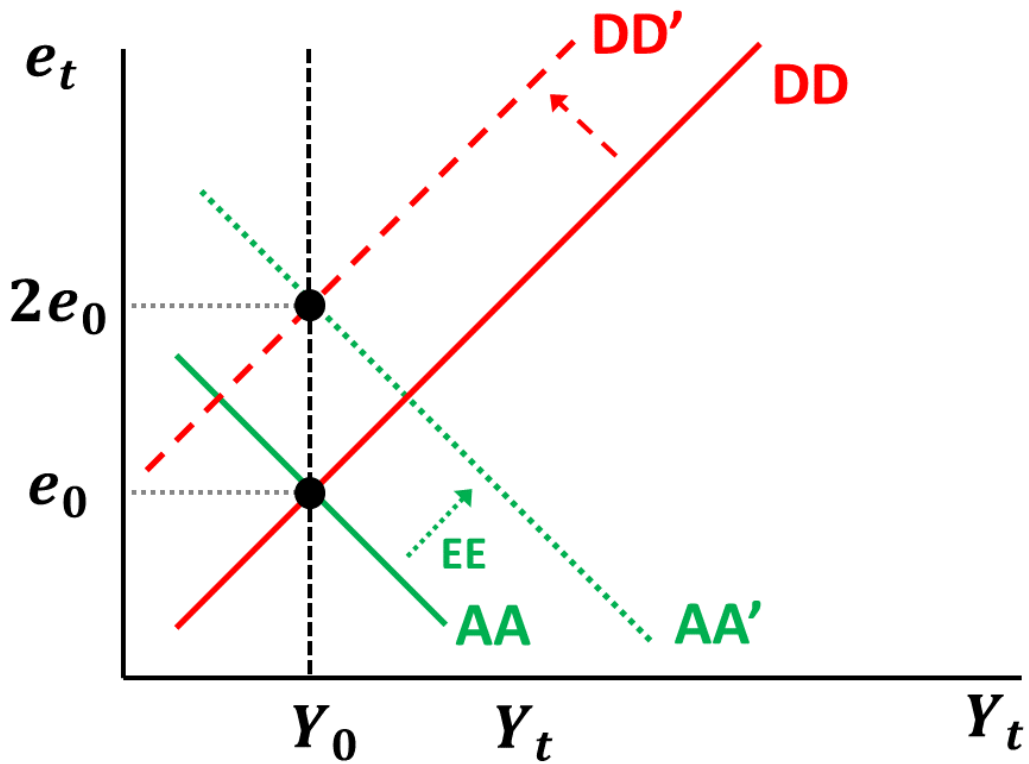
Overall Equilibrium.



# Question B1 - (c) Graphical II

- Let's declutter the previous diagram.
- The new long run equilibrium is on AA' at $(\bar{Y}, 2e_0)$.

Overall Equilibrium (Long Run).



# Question B1 - (c) Intuition

- In the long-run money is neutral. All nominal variables change by **same amount**.
- In particular, $P$ **gradually increases** by 100%, just like $M$.
- Without further $M \uparrow$, the net effect on **real** money balances is eventually zero. Thus, price adjustment means the liquidity effect reverses. AA curve **shifts back**.
- **Real** exchange rate depreciation also reverses, as $\epsilon = \frac{eP^*}{P}$, $\hat{P} = \hat{e}$ and $\hat{P}^* = 0$. For any given **nominal** exchange rate, $Y$ lower; DD curve shifts inward (up) such that ultimately, $Y = \bar{Y}$.

# Question B1 - (d) Question

- (d) *Show graphically the short run effect and long run adjustment of an unanticipated permanent increase in the level of money supply by* 100% *and explain how it affects the slope of the AA and DD curves, and whether exchange rate overshooting is likely to occur, assuming that*:

  1. The exchange rate sensitivity of the current account is zero.
  2. The exchange rate sensitivity of the current account is infinite.
  3. The output sensitivity of money demand is zero.
  4. The output sensitivity of money demand is infinite.

- *In each case, explain how it affects the slope of the AA and DD curves, and whether exchange rate overshooting is likely to occur.*

# Question B1 - (d) Overshooting

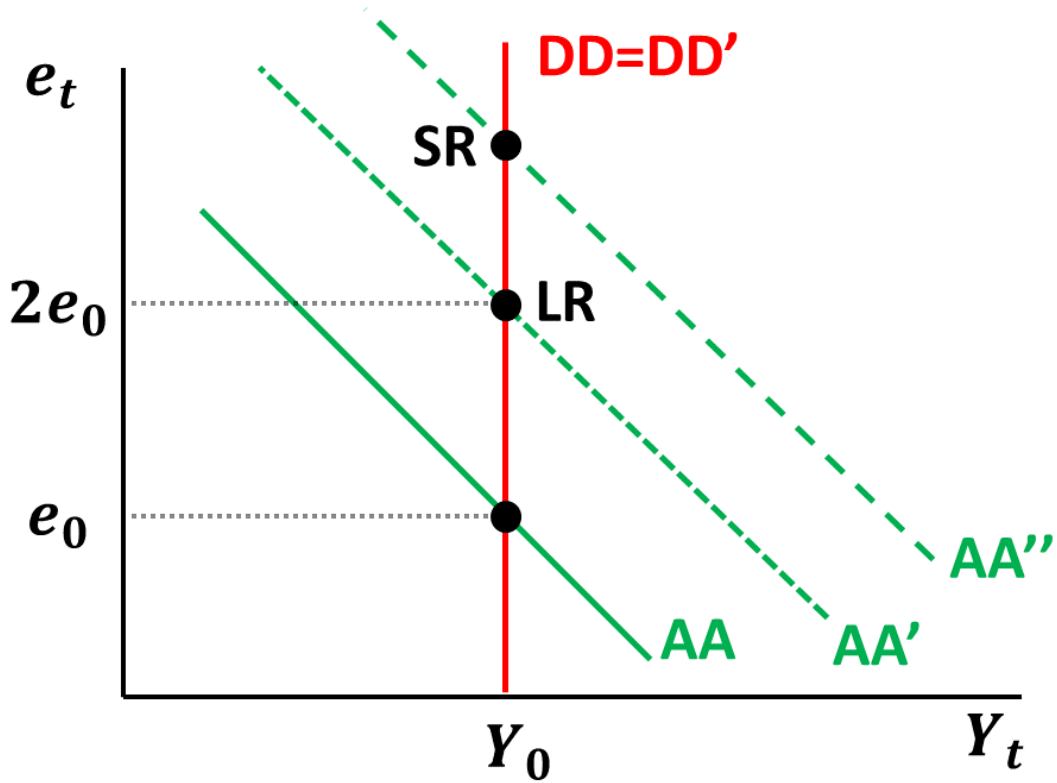
- Whether exchange rate overshooting occurs depends on size of AA curve shifts and gradients of AA and DD, i.e., on **parametrisation** (see question B2).

- Four cases to consider.

# Question B1 - (d) Case I

- The exchange rate sensitivity of the current account is **zero**.
- Output invariant to changes in exchange rate, so **DD vertical**. Overshooting **likely**.

Vertical DD.

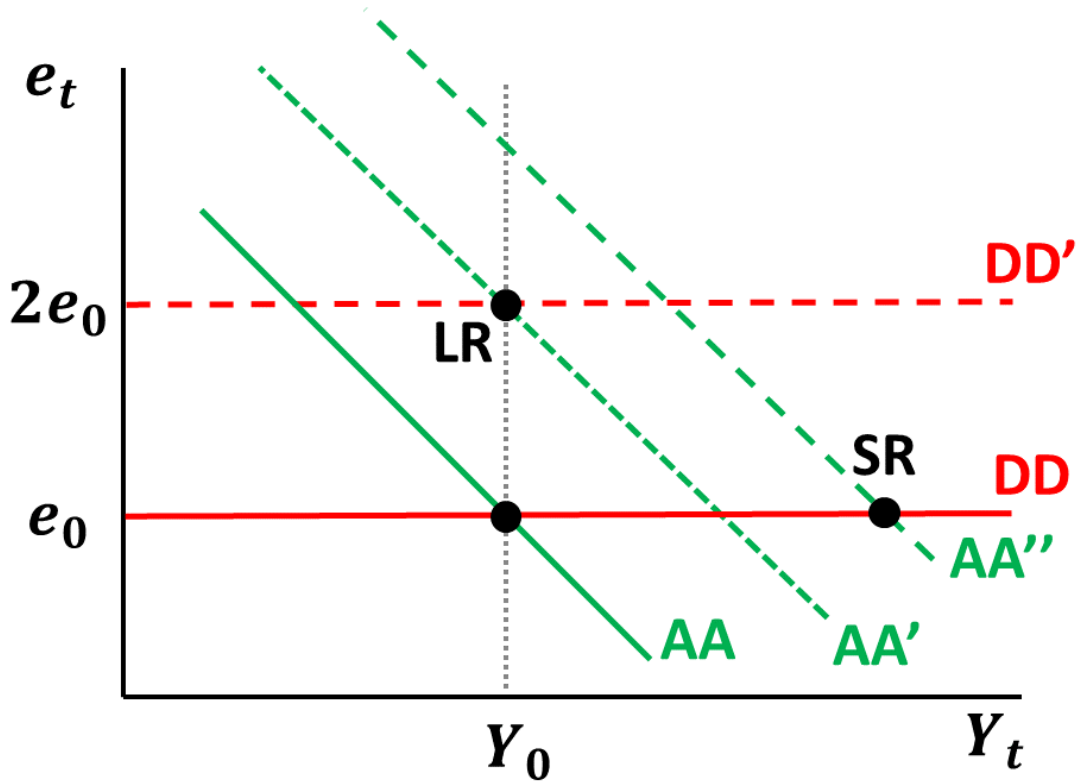


# Question B1 - (d) Case II

- The exchange rate sensitivity of the current account is **infinite**. Small $\Delta e$ lead to large (infinite) $\Delta Y$.

- **DD horizontal**. Overshooting **not possible**.

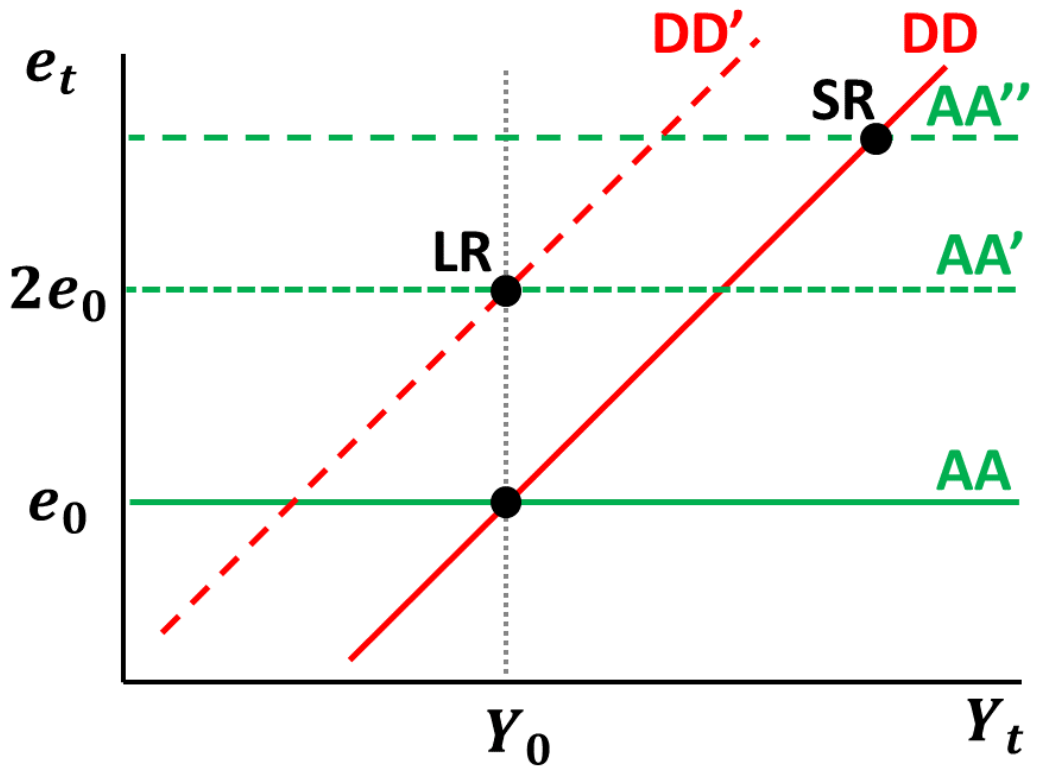
Horizontal DD.



# Question B1 - (d) Case III

- The output sensitivity of money demand is **zero**.
- **Horizontal AA**, with overshooting **likely**.

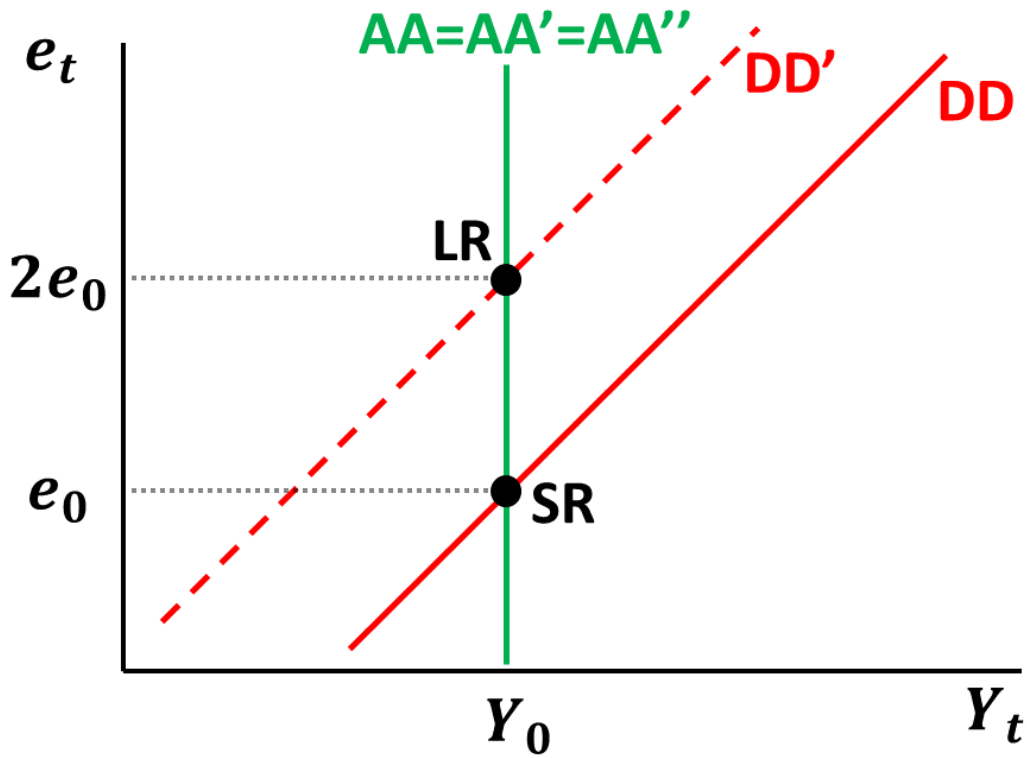
Horizontal AA.



# Question B1 - (d) Case IV

- The output sensitivity of money demand is **infinite**.
- The AA curve is **vertical** and overshooting is **not possible**.

Vertical AA.



# Question B2 - Set Up

- *B2. Consider the following model of a small open economy (Home), which interacts with the rest of the world (Foreign)*:

$$
\begin{aligned}
i &= i^* + \mathbb{E}[e] - e, \\
M - P &= \lambda Y - \kappa i, \\
Y &= \alpha(e + P^* - P).
\end{aligned}
$$

*where $i$ is the Home nominal interest rate, $i^*$ the Foreign nominal interest rate, $e$ the nominal exchange rate expressed as the Home price of Foreign currency, $\mathbb{E}[e]$ the expected future exchange rate, $M$ the home money supply, $P$ the Home aggregate price level and $P^*$ the Foreign price level. In terms of notation, $M$, $P$, $Y$ and $Y^*$ are in logs. Assume that people have rational expectations. In the short-run, the aggregate price level is fixed. In the long run, it is flexible and output is at its natural rate, $\bar{Y}$. Assume that: $\lambda = \kappa = 1$, $\alpha = \frac{1}{2}$, $i^* = P^* = \bar{Y} = 0$ and $M = \bar{M}$.*

# Question B2 - (a) Equation Description

- (a) *Give a brief economic interpretation of the three displayed equations above.*

- **UIP**, which may be derived from a no-arbitrage condition between deposits in the Home and Foreign countries:

$$i = i^* + \mathbb{E}[e] - e.$$

- Money market equilibrium (**LM curve**). Real money demand depends positively on output (transactions motive) and negatively on $i$ (opportunity cost):

$$M - P = \lambda Y - \kappa i.$$

- Goods market equilibrium (**DD curve**). A real depreciation will raise aggregate demand: $\frac{\partial Y}{\partial \epsilon} > 0$, where $\epsilon \equiv e + P^* - P$ (assumes Marshall-Lerner condition is satisfied).

$$Y = \alpha(e + P^* - P).$$

# Question B2 - (b) Derive AA and DD Curves

- (b) *Compute the long run equilibrium values of* $i, P, e$ *and* $\mathbb{E}[e]$.

- Begin by identifying the AA and DD curves.

- AA obtained by combining equilibrium conditions from the two asset markets (foreign exchange and money market) to eliminate $i$. The AA curve is **downward sloping**.

$$e = \frac{1}{\kappa}(M - P - \lambda Y) + i^* + \mathbb{E}[e], \qquad \text{(AA)}$$

- DD curve is a a rearrangement of goods market equilibrium (above) and is **upward sloping**.

$$e = \frac{1}{\alpha} Y - P^* + P. \qquad \text{(DD)}$$

# Question B2 - (b) Take Rational Expectations

- In the long-run, $Y = \bar{Y}$, $M = \bar{M}$, $P = \bar{P}$, $e = \mathbb{E}[e] = \bar{e}$, such that the system becomes:

$$0 = \frac{1}{\kappa}(\bar{M} - \bar{P} - \lambda \bar{Y}) + i^*,$$
$$\bar{e} = \frac{1}{\alpha}\bar{Y} - P^* + \bar{P}.$$

- The first equation may then be solved for $\bar{P}$ and used in the second to solve for $\bar{e}$ as:

$$\bar{P} = \bar{M} - \lambda \bar{Y} + \kappa i^*,$$
$$\bar{e} = \frac{1 - \alpha\lambda}{\alpha}\bar{Y} - P^* + \bar{M} + \kappa i^*.$$

# Question B2 - (b) Note Down Solutions

- Finally $\bar{i}$ may be found using the UIP condition with $e = \mathbb{E}[e]$ to give $\bar{i} = i^*$

- We will construct a results table. First line contains analytical results. Second line imposes the **normalisation** $i^* = P^* = \bar{Y} = 0$ and $M = \bar{M}$.

Results

| | $i$ | $P$ | $e$ | $\mathbb{E}[e]$ |
|---|---|---|---|---|
| *Long Run* | | | | |
| Analytical | $i^*$ | $\bar{M} - \lambda\bar{Y} + \kappa i^*$ | $\frac{1-\alpha\lambda}{\alpha}\bar{Y} - P^* + \bar{M} + \kappa i^*$ | $\frac{1-\alpha\lambda}{\alpha}\bar{Y} - P^* + \bar{M} + \kappa i^*$ |
| Calibrated | 0 | $\bar{M}$ | $\bar{M}$ | $\bar{M}$ |

# Question B2 - (c) Long Run Impact of Shock

- (c) *Suppose that there is an unanticipated permanent decrease in the (log) Home money supply from $M = 0$ to $M = -1$. Compute the new short run equilibrium level of output, $Y$, and the exchange rate, $e$, and give an intuitive explanation of the short run effect.*
- Always start with the **long run** impact. Use given values of money supply.

Results

| | $i$ | $P$ | $e$ | $\mathbb{E}[e]$ |
|---|---|---|---|---|
| *Long Run* | | | | |
| Analytical | $i^*$ | $\bar{M} - \lambda\bar{Y} + \kappa i^*$ | $\frac{1-\alpha\lambda}{\alpha}\bar{Y} - P^* + \bar{M} + \kappa i^*$ | $\frac{1-\alpha\lambda}{\alpha}\bar{Y} - P^* + \bar{M} + \kappa i^*$ |
| Calibrated | 0 | $\bar{M}$ | $\bar{M}$ | $\bar{M}$ |
| *Shock* | | | | |
| Initial | 0 | 0 | 0 | 0 |
| Final | 0 | $-1$ | $-1$ | $-1$ |

# Question B2 - (c) Short Run Impact of Shock

- The AA and DD curves will give us the short-run equilibrium.

$$e = \frac{1}{\kappa}(M - P - \lambda Y) + i^* + \mathbb{E}[e], \qquad \text{(AA)}$$

$$e = \frac{1}{\alpha} Y - P^* + P. \qquad \text{(DD)}$$

- The initial **normalisation** gives:

$$e = -\frac{\lambda}{\kappa} Y, \qquad (AA_0)$$

$$e = \frac{1}{\alpha} Y. \qquad (DD_0)$$

- Following the unanticipated and permanent decrease in $M$ (but $P$ sticky):

$$e = \frac{1}{\kappa}(-1 - \lambda Y) - 1 = -\frac{\lambda}{\kappa} Y - \frac{1+\kappa}{\lambda}, \qquad (AA_1)$$

- No change in DD, so interpret as **downward shift in AA**.

# Question B2 - (c) Short Run Equilibrium

- Equating $AA_1$ and $DD_0$ yields:

$$\frac{1}{\alpha}Y = -\frac{\lambda}{\kappa}Y - \frac{1+\kappa}{\lambda}, \qquad \rightarrow \qquad Y = -\frac{\alpha(1+\kappa)}{\kappa+\lambda\alpha}.$$

- Plug back into DD to obtain $e$:

$$e = \frac{1}{\alpha}Y, \qquad \rightarrow \qquad e = -\frac{1+\kappa}{\kappa+\lambda\alpha}.$$

- Finally, **calibrate** using $\lambda = \kappa = 1$ and $\alpha = \frac{1}{2}$:

$$Y = -\frac{2}{3}, \qquad \text{and} \qquad e = -\frac{4}{3}.$$

- Using UIP, we can also find the nominal interest rate:

$$i = i^* + \mathbb{E}[e] - e = 0 - 1 + \frac{4}{3} = \frac{1}{3}.$$

# Question B2 - (c) Intuition

- In the short run, the price level is fixed today;
- A lower level of money supply is met with a higher nominal (and real) interest rate and the expectation of a future currency **appreciation** from the current level;
- To maintain asset market equilibrium the exchange rate **appreciates today**;
- As Foreign goods are now cheaper in Home currency, the current account deteriorates as consumer switch expenditure towards imported products. The current level of output therefore **falls**.

# Question B2 - (d)

- (d) *Does this decrease in the money supply lead to exchange rate overshooting? Explain intuitively how the economy adjusts to the new long run equilibrium.*

- **Yes**. This example clearly has exchange rate overshooting. The magnitude of the short-run change (-4/3) is larger than the long-run (-1).

# Question B2 - (d)

- Add short run impact to the results table:

Results

| | $i$ | $P$ | $e$ | $\mathbb{E}[e]$ |
|---|---|---|---|---|
| *Long Run* | | | | |
| Analytical | $i^*$ | $\bar{M} - \lambda\bar{Y} + \kappa i^*$ | $\frac{1-\alpha\lambda}{\alpha}\bar{Y} - P^* + \bar{M} + \kappa i^*$ | $\frac{1-\alpha\lambda}{\alpha}\bar{Y} - P^* + \bar{M} + \kappa i^*$ |
| Calibrated | 0 | $\bar{M}$ | $\bar{M}$ | $\bar{M}$ |
| *Shock* | | | | |
| Initial | 0 | 0 | 0 | 0 |
| Short Run | 1/3 | 0 | $-4/3$ | $-1$ |
| Final | 0 | $-1$ | $-1$ | $-1$ |

- Consider role of **calibration** in delivering this result:

$$e = -\frac{1+\kappa}{\kappa + \lambda\alpha} \lesseqgtr -1.$$

- As $\lambda \to \infty$ and $\kappa \to 0$ (vertical AA), then $e \to 0$, and **no overshooting**.
- As $\alpha \to \infty$ (horizontal DD), then $e \to 0$, and **no overshooting**.

# Next Class

# Next Class

- Final part of "new" material, International 2.