Eco202 Equation Sheet

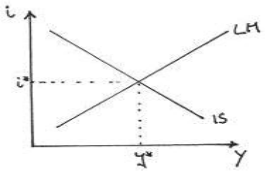
This *study sheet* includes the part of the course labelled "*The Core*" in the textbook: The economy in the short, medium and long run. In the past, this material accounted for 50-75 percent of the final exam.
Please note that this is study sheet is just a *brief summary*, and does not replace the textbook in any way. Good luck!

I. SHORT RUN

1. IS-LM IN A CLOSED ECONOMY

- The **IS curve** describes a relationship between output and the interest rate; along the IS curve the goods market is in equilibrium.
- The **LM curve** also describes a relationship between output and interest rate; along the LM curve the financial market is in equilibrium.

For the economy to be in equilibrium both markets have to be simultaneously in equilibrium:



A mathematical example :

Given : C = 100 + 0.6 (Y-T)
G = 200, T = 200, I = 100 – 10i
(M/P)d = 2Y – 200i ;
(M/P)s = 2000/4 = 500

IS: **Yd = C+I+G**
= 280 + 0.6Y – 10i
Yd = Y → 280 – 10i = 0.4Y
→ Y = 700 – 25i (IS)

LM: **Ms = Md** → 2Y – 200i = 500
→ Y = 250 + 100i (LM)

IS = LM → 700 – 25i = 250 + 100i
→ i* = 3.6 → Y* = 610

POLICY EFFECTS ON IS AND LM:

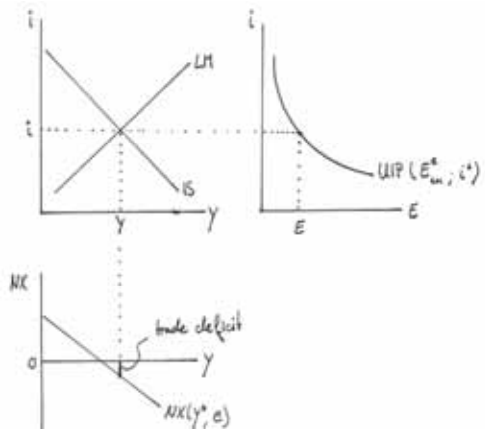
Policy	IS	LM	Output	Interest Rate
↑ in taxes	left/ down (reduction in demand)	--	down	down
↓ in taxes	right/ up	--	up	up
↑ in spending	right/ up (increase in demand)	--	up	up
↓ in spending	left/ down	--	down	down
↑ in money	--	right/ down (move along Md)	up	down
↓ in money	--	left/ up	down	up

2. IS-LM IN AN OPEN ECONOMY

- distinguish between domestic demand and demand for domestic goods
- if demand for domestic goods > domestic demand → trade surplus

a) with flexible exchange rates

- demand in the goods market:
  Yd = C(Y-T) + I(Y,i) + G + NX(Y,Y*,e)
- UIP: $i_t = i_t^* + \frac{E_{t+1}^e - E_t}{E_t}$



The goods market gives the IS curve and the money market the LM curve. The intersection determines the equilibrium level of output and interest rate.

Given i* and E^e the UIP determines the exchange rate E.

Depending on import and export demand net exports may or may not be positive.

What happens if

- Increase in gov't spending/ reduction in taxes:
  a. Demand increases → IS shifts up, moving along LM → Y, i increase
  b. i up → E down (appreciation) (move along UIP)
- Increase in foreign income:
  a. Export demand increases → IS and NX-curve shift up
  b. IS shifts up, moving along LM → Y, i increase
  c. i up → E down (appreciation) (move along UIP)
- Increase in foreign price level
  a. P* up → real exchange rate up (real depreciation)
  b. e up → increases export demand, reduces import demand
  c. IS and NX-curve shift up → Y, i increase
  d. i up → E down (appreciation) (move along UIP)
- Increase in expected future exchange rate (E^e up, depreciation)
  a. UIP-curve shifts up/ right (E has to go up for UIP to hold)
  b. UIP shift → E up → e up (real depreciation)
  c. e up → increases export demand, reduces import demand
  e. IS and NX-curve shift up
  d. i up → E down (appreciation), move along new UIP, but not all the way
- Increase in money supply
  a. LM shifts right → Y increases, i decreases
  b. i lower → E up (move along UIP), nominal and real depreciation

(b) with fixed exchange rates

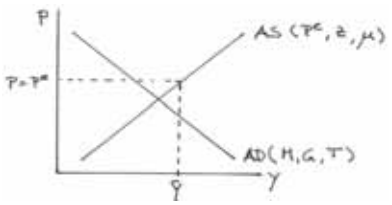
- fixed exchange rate → nominal exchange rate cannot change
- i = i*, the domestic interest rate is fixed by the foreign interest rate
- money supply has to be such that LM intersects IS at i = i*
- no monetary policy possible

What happens if

- Increase in money supply
  a. LM shifts right → i decreases
  b. i lower → E up → but E can't change → LM shifts back (M^S down), i = i*
- Increase in gov't spending/ reduction in taxes:
  a. IS shifts up, moving along LM → Y, i increase
  b. i up → E down → but E can't change → LM shifts right, i = i*
  c. Y increased "a lot" → move along NX, trade balance worsened
- Increase in foreign price level
  a. P* up → real exchange rate up (real depreciation)
  b. e up → increases export demand, reduces import demand
  c. IS and NX-curve shift up
  d. Rest like increase gov't spending

II. MEDIUM RUN IN A CLOSED ECONOMY

- The **AD curve** describes a relationship between output and the price level; along the AD curve the both goods and financial market are in equilibrium.
- The **AS curve** describes a relationship between output and the price level; it is derived from the labour market and firms' price setting behaviour



note: the natural level of output (Ybar) is the point on the AS at $P = P^e$

What happens if

	AS	AD	P	Y
Increase in mark-up (1+μ) [i.e. everything that improves firms market power]	up	--	up	down
Increase bargaining power (z up) [or something else that increases z]	up	--	up	down
Increase in structural change [or something else that decreases z]	down	--	down	up
Increase in money supply	--	up	up	up
Increase in gov't spending	--	up	up	up

III. MEDIUM RUN IN AN OPEN ECONOMY

The medium run in an open economy differs from the medium run in a closed economy only by the aggregate demand relationship, the supply is unchanged. As in the IS-LM framework the key difference is the distinction between demand for domestic goods and domestic demand.

(A) DYNAMICS OF AS-AD WITH FLEXIBLE EXCHANGE RATES

- demand for domestic goods = domestic demand – imports + exports

  Y = C(Y-T) + I(Y,i) + G + NX(Y,Y*,e)

  e – real exchange rate = price of foreign goods in domestic goods
- UIP must hold
- Changes in p cause a change in the real exchange rate → NX curve shifts → IS/ AD curves shift
- Medium run: Y=Ybar, prices adjust → change in real exchange rate

Key difference to closed economy:
Fall in price level causes a depreciation of the real exchange rate (e up) → increase demand for domestic goods → IS and AD shift right

(B) DYNAMICS OF AS-AD WITH FIXED EXCHANGE RATES

- fixed exchange rate implies i = i*
- money supply/ LM curve determined by IS and i*
- changes in price level change the real exchange rate 1:1 because the nominal exchange rate cannot adjust

Key difference to closed economy:
Interest rate predetermined→ no independent monetary policy (LM fixed by i* and IS)
Fall in price level causes a depreciation of the real exchange rate (e up) → increase demand for domestic goods → IS and AD shift right

IV. THE SOLOW MODEL

- Aggregate production function Y = F(K,AN)
- AN – effective labour or efficiency units
- Constant returns to scale, decreasing marginal products
- A grows at rate g, N grows at rate n
- Output per effective worker Y/AN = y = F(K/AN, 1) = f(k)

Fundamental Solow equation

$$K_{t+1} = (1-\delta)K_t + sF(K_t, AN) \quad \big| / AN$$

$$k_{t+1} = (1-\delta)k_t - (g+n)k_t + sf(k_t)$$

$$k_{t+1} - k_t = \Delta k_t = sf(k_t) - (\delta + n + g)k_t$$

i.e. the change in per effective worker capital is equal to savings/ investment per effective worker minus depreciation and adjustment for growth in the number of effective workers

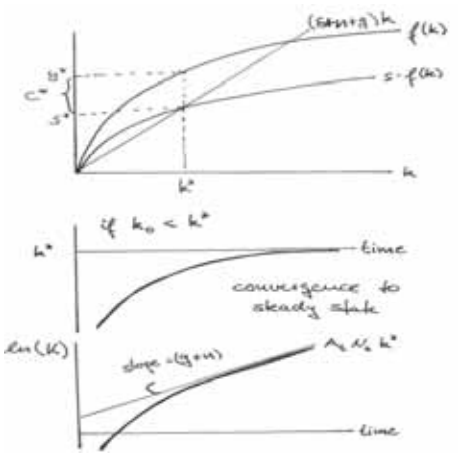
Steady State
In the steady state output per worker is constant, hence worker per capita must be constant

$$\Delta k^* = sf(k^*) - (\delta + n + g)k^* = 0$$

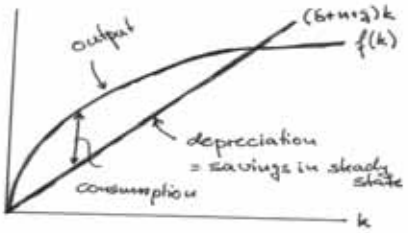
i.e. in the steady state output per effective worker growth is zero, independent of the savings rate

Total output grows at rate (n+g):
$Y = AN_y \rightarrow \Delta Y/Y = \Delta(ANy)/(ANy) = \Delta A/A + \Delta N/N + \Delta y/y = g + n + 0 = (g+n)$

Output per worker grows at rate g:
$Y/N = Ay \rightarrow \Delta(Y/N)/(Y/N) = \Delta(Ay)/(Ay) = \Delta A/A + \Delta y/y = g + 0 = g$



The Golden Rule
- Find the savings rate that maximizes steady state consumption
- consumption = output – savings = output – depreciation (in steady state)
- → maximize distance between f(k) and (δ+n+g)k
- → find k** such that f'(k**) = δ+n+g



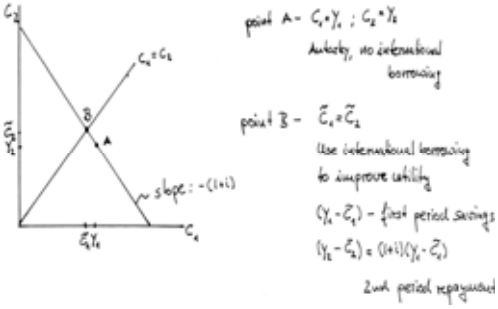
To maximize consumption the slopes of the 2 curves need to be equal
→ f'(k) = (δ+n+g)

VI. TWO-PERIOD BORROWING

1. Consumption Choice without Investment

1st period saving/ borrowing = $(Y_1 – C_1)$
2nd period repayment = $(1+ i)*(Y_1 – C_1)$

→ 2nd period budget: $C_2 = Y_2 + (1+ i)*(Y_1 – C_1)$



note:
current account period 1 = $(Y_1 – C_1)$ [=savings]
current account period 2 = i*CA1 + $(Y_2 – C_2)$ [=interest payment + savings]

How to solve?
2 conditions:

1. $C_2 = Y_2 + (1+ i)*(Y_1 – C_1)$ (budget)
2. $C_1 = C_2$ (optimality)

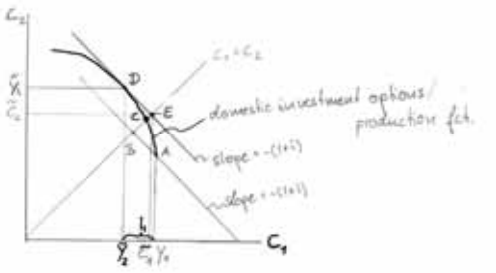
Combine: $C_1 = Y_2 + (1+ i)*(Y_1 – C_1)$ → $C_1 = [Y_2 + (1+ i)*Y_1] / [2+i]$

$C_1 = C_2$, Saving/ Borrowing = $(Y_1 – C_1) = [Y_1 – Y_2] / [2+i]$

→ international borrowing makes country better off

2. Consumption Choice with Investment

- Closed economy with investment: Invest such that consumption in both periods equal
- Marginal product of capital could be very high/ low → inefficient
- If MP high borrow money this period and pay back next period
  → better off, because return (MP) higher than interest rate
- If MP low lend money rather than invest and collect interest payments next period
  → better off, because return on lending (interest rate) higher than on investing (MP)



point A – initial equilibrium/ endowment
point B – optimal allocation without investment but international borrowing (part 1)

point C – outcome with only domestic investment, marginal product of capital is higher than interest rate (slope production/ investment function steeper than (1+i))
→ inefficient → borrow money to invest until MP = (1+i)
point D – optimal investment: marginal product = (1+i)
point E – resulting consumption point

This economy borrows from abroad to take advantage of domestic investment opportunities → economy better off

note:
current account period 1 = $(Y_1 – C_1 – I_1)$
current account period 2 = i*CA1 + $(Y_2 – C_2)$

How to solve?
Separation between in investment and consumption decision:

1. Find optimal investment level: MP = (1+i)
2. Use after-investment income and period 1 ($=Y_1–I_1$;$\tilde{Y}_1$ in the graph) and after-investment income in period 2 ($\tilde{Y}_2$ in the graph) and borrow along budget line with slope -(1+i).
   i.e. use point D, rather than point A, and repeat exercise from part1

→ Investment and consumption decision are independent!