INTERMEDIATE MARCOECONOMIC

ECON 302 LECTURE NOTES

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CONTENTS

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1. **Macro econ about**
    - Study Structure and performance of national economic; Policy governments use to affect economic performance
    - Top-down approach. An analytical tool used to craft economic and fiscal policy
2. **Increases in economic** Two mean sources of growth of output
    - Population growth
    - Increase in average labour productivity (in the long run)

    Then the incr
3. **Rate of Growth of Economic Deterimined by**
    - rate of saving and investment
    - rate of technological change
    - rate of change in other factors (i.e human capital population etc.)
4. **Business cycles**

    Business cycles refers to the short-run movements (expansions and recession) of economic activity. It is the downwards and upward movement of gross domestic product (GDP) around its long-term growth.

    From peak to recession to trough to expansion to peak. Recession is also called contractions. Recessions are accompanied by high unemployment rate. Loss of human capital in recession.

    Derivation of unemployment rate. Population is composed of **Working age population** and **Non-working age population**. Working age population can be divided in to **labour force** and **not in labour force** and finally labour force consists **employed** and **unemployed**.

    The problem is **employed** part includes both part time and full time employees while some of them are involuntarily part time (i.e can't find a full time job) while it is still be considered 'employed'.

    Finally, the unemployment rate is defined as

$$\frac{\textbf{Unemployment}}{\textbf{Labour force}}$$

5. **Inflation and Deflation**

   Price level goes up ⟶ inflation other wise deflation. If the inflation rate goes down it is called **disinflation**

   In summary the economic performance depends on

   - Natural and human capital
   - Capital stock
   - technology
   - economic choices made by citizens
   - Macroeconomic policies of the governement

   Macro economic policies includes Fiscal policy and Monetary policy.

6. **Aggregation**

   Macro. ignore distinctions between individual product markets and focus on national totals. The process of summing individual economic variables to obtain economy wide totals is called aggregation.

7. **The steps develop and testing economic theory**

   - State research question
   - Make provisional assumption
   - Work out the implication of theory
   - Conduct an empirical analysis to compare the implication of the theory with the data
   - Evaluate the results of your comparisons

   this connect the data with theory.

8. **Comparative Static Experiments**

   Static means Equilibrium. First the economic model is assumed to be at equilibrium. Then change the value of one variable in the model, a variable whose value is not affected by changes in other variables in the model (called a shock). Finally observe responds of the model.

9. **Classical vs Keynesians**

   (a) **Classical**

   - Economy works well on its own. The invisible hand means **If there are free market and indiciduals conduct thier economic affairs in their own best interests, the overall economy will work well.**

- Price is dynamic. Price and wages adjust to equilibrium rapidly. Changes in wages and prices are signals that coordinate people's actions. So unemployment won't last.
- Results: Government should only have limited role in the economy. No interruption in economy.

(b) **Keynesians**

- In the short run the price is sticky.
- Classical failed since high unemployment was persistent. Wages and price adjust slow so market remain out of equilibrium for long period. It goes back to equilibrium until government step in.
- Results: Government should intervene to restore full employment.

1 CHAPTER 2: THE MEASURE & STRUCTURE OF ECONOMY

1.1 *National Income Accounting*

There are 3 approaches for national income calculation.

- **Product approach**: Amount of output produced, excluding output used up in intermediate stages of production. So it should be the sum of value added.

  1.1 EXAMPLE. A,B,C are 3 companies, and P be the public. A $\xrightarrow{a}$ B $\xrightarrow{b}$ C $\xrightarrow{c}$ P where a,b and c are the price of product sold to other company as an intermediate production. Then the total value added is

  $$a + (b - a) + (c - b) = c$$

- **Income approach**: Incomes received by the producers of output. Notice in this approach, we should includes tax to government and profit of business owner (NOT cooperation). So usually it consists of

  Wages to Employees + Taxes + Profit (Revenue - ALL cost)

- **Expenditure approach***: Amount of spending by the ultimate purchasers of output. Ultimate goods price.

In summary, these three approaches are equivalent

Total Production = Total Income = Total Expenditure

1.2 *GDP and GNP*

GDP is the **market** value of **final goods and services newly** produced within a nation during a fixed period of time. GDP can be measured by the 3 approaches above.

GNP is the market value of final goods newly produced by domestic factors of production (capital, labour) during the current period.

So the relationship becomes

$$\textbf{GDP + NFP = GNP}$$

where NFP is **net factor payment from abroad** = income paid to domestic factors of production by the rest of the world - income paid to foreign factor of production by the domestic economy.

1. **GPD by product approach**

   GDP includes only new goods and services. It is a sum of value added. Using market value allows adding different goods and services. Problems of using market value:

   - Some goods are not sold in markets (i.e Using cash or debit card not recoded for tax purpose).
   - Underground economy.
   - Government investment is hard to compute by market value.

2. **GPD by Expenditure Approach**

   The formula is the same as before

   $$\textbf{GDP = C + I + G + (X-IM)} \tag{1}$$

   Transfer payment, technically, not included in GDP. First it is different from a insurance. An insurance is that the policyholder pays a premium and when accident happens, he can claim the loss. Transfer payment is not. Usually people do not pay anything in advance and, for example, when they become unemployed, they get money from the government for free.

   However, if they spend the money they receive from the government, the money goes to C immediately and become part of GDP. Approximately, G is 21.2% of the GDP in Canada. Notice how to deal with inventory (in expenditure approach). Say a good is sold in last year for $3 while this year for $4. Then it is recorded in investment for $3 dollars last year while $1 dollars in consumption this year. If no change in price then no recording this year.

3. **GDP by income approach**

   - **Compensation of employees (51.6% of GDP):** Total remuneration (salary), in cash or in kind, payable by an enterprise to an employee in return for work done

- **Gross operating surplus (25.7% of GDP):** Income earned from the production of goods and services that is paid to the owners of incorporated companies. Dividends and other sorts of investment income
- **Gross missed income (11.7% of GDP)**: Income paid to unincorporated enterprises. (i.e family owned groceries store, sole-prop. + partnership)
- **Taxes less subsidies on production: (4.3% of GDP)** Taxes (less subsidies received) that companies pay on the use of labour, machinery, buildings, or other assets used in the production of goods and services. Tax w.r.t the process of producing product
- **Taxes less subsidies on products and imports: (6.6% of GDP)**: taxes payable after a product is produced and sold in Canada or imported from abroad. Taxes w.r.t the selling of product

Then we can divide GDP in to private and government sector.

- **Private disposable income (PDI)**: The amount of income the private sector has available to spend after paying taxes and receiving government transfers.

$$\text{PDI} = \underbrace{\text{Y} - \text{NFP}}_{\text{GNP}} - \text{T} + \text{TR} + \textbf{INT}$$

where **NFP** is the net factor payment from abroad. **Y** is GDP, **TR** is transfers received from government, **T** is tax. **INT** is the interest payments on government's debt(bond). INT is NOT part of GDP. It is also not a part of any of the fives categories mentioned above.

- **Net government Income:**

$$\text{NGI} = \text{T} - \text{TR} - \text{INT}$$

however, we say government has budget surplus or deficit if

$$\text{NGI} - \text{G} > 0 \text{ or } < 0$$

Personal understanding is NGI not includes the G expenditure is that T is all from people, whatever types. TR and INT is the part that is returned back to people while G is the actual spending of the government.

1.3 *Saving and Wealth*

Wealth = assets - liability. Saving = current income - spending on current needs. There are two concepts, one is stock (i.e balance sheet) and one

is flow (i.e). We assume proportion MPS/MPC is constant (marginal property to save/ marginal property to spend).

Total saving is

$$S_{total} = Y + NFP - C - G =$$

$$= (C + I + G + NX) + NFP - C - G$$

$$= I + (NX + NFP)$$

$$= I + CA$$

Private saving is

$$S_{private} = S_{total} - S_{gov} = I + CA - S_{gov}$$

Notice we define the disposable income as $Y_d = Y - T$ where no transfer factors is added. Private saving is used in three ways:

- Investment
- Government budget deficit: When government need money but they don't want to issue too much bound they borrow money.
- Current account balance

shown by the above equation.

1.4 *GDP and CPI Deflator*

A price index is a measure of average level of prices (for specific basket of good and services). It has bias. The type of goods and services can be the same while the quality can be improved.

1.2 DEFINITION. The GDP deflator is a price index that measure the overall level of prices of goods and services included in GDP.

$$\textbf{GDP Deflator} = \frac{\textbf{Nominal GDP}}{\textbf{Real GDP}} * 100$$

which depends on the chose of base year.

Nominal GDP is exactly the real GDP in the base year.

1.3 DEFINITION. Rate of inflation is the percentage rate of increase in a price index CPI (can be others) per a period of time.

$$\pi_{t+1} = \frac{P_{t+1} - P_t}{P_t} = \frac{\Delta P_{t+1}}{P_t}$$

1.4 DEFINITION. Nominal rate and real rate

$$\textbf{Nominal rate(i)} \approx \textbf{Real rate(r)} + \textbf{Expected inflation}(\pi)$$

precisely it is

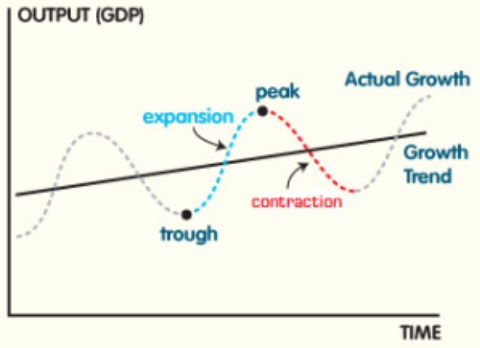
$$RR = \frac{1 + NR}{1 + \pi^e} - 1$$

2 ECONOMIC GROWTH THEORY

Economic growth is referring to the **sustained** expansion of production probability measured as the increase in real GDP (or potential GDP). Like the expansion of PPF (production probability frontier). The **standard of living** depends on **Real GDP per capita** (i.e real GDP/population). So it growth only if real GDP grow faster than population.

Real Economic increase has 2 distinct reasons:

- Economy is returning to full employment in an expansion phase of business cycles (i.e from through to peak in the picture below).
- **Potential GDP** might increasing. (The straight line below)



Notice the return to full employment in an expansion phase of business cycle isn't economic growth. This can be illustrated as the point inside the ppf and returning to the frontier, and the shifting of ppf.

The *rule of 70* states that the number of years for the level of a variable to double is approximately 70/annual percentage growth rate of the variable.

2.1 *Determination of Potential GDP*

The model used is the one with two components: An aggregate production function and an aggregate labour market. The function is

$$Y = A * f(K, L)$$

where A is a constant which sometimes called the total factor of production. It is a measure of overall effectiveness with which capital and labor are used, K is capital and L is labour. The discussion of marginal production of labour/capital is omitted (i.e diminishing marginal return). The reason of diminishing return is caused by the fix of the other production factor. For example a machine need 10 people to operate. Then if you add one more

worker the return only increase a little bit. The shock of production function is by improved tech, pandemic (negative, earthquake).

2.2 *Labour*

Overlap with econ301 partly. Consider labour and leisure as substitution. This is important when comes to discussion about labour supply and demand, especially supply.

1. **Demand of Labour**

   Assume capital is fixed in short-run. It is long-lived and has been build over years. Assume amount of labour is variable and they are all alike. Assume wages is determined in a competitive market. Assume the firm employ workers to max profit (i.e marginal cost = marginal revenue, here MPL = wage (real). See ECON 301). Actually the wage is get from

   $$W = MPL \times P$$

   where W is nominal wage. So the real wage is W/p = MPL. p is the price of product produced. The marginal revenue production of labour (MRPN) is +a worker → how much more revenue. It is the same equation as above

   $$MRPN = P \times MPL$$

   which equals nominal wages.

2. **Supply of Labour**

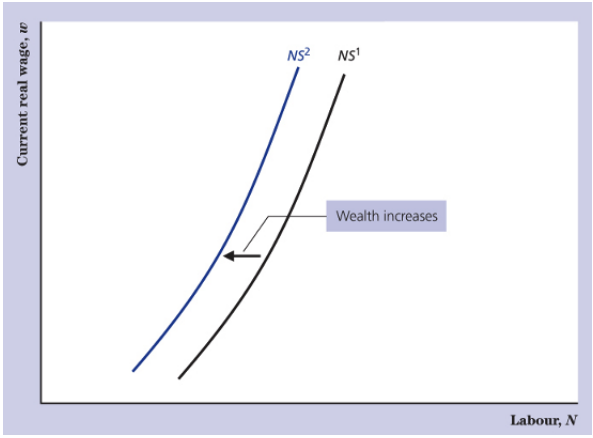
   See 301. Not testing. Remember leisure and labour are substitute. Notice two effect:

   - **Substitution Effect:** Wage ↑ $\implies$ Leisure ↓ $\implies$ Labour ↑
   - **Income Effect:** Wage ↑ $\implies$ richer $\implies$ Leisure ↑ $\implies$ Labour ↓

   The supply curve is upward sloping which assume substitution effect is greater than the income effect.

   Then there can be some shock in labour supply.

   - **Wealth** ↑: When wealth increase, people work less



The increase of wealth do not necessary need increase in income (i.e stock return).

3. **Labour Market Equilibrium**

   Classical model assumes **real wages adjusts quickly to equilibrium**. After adjustment, the equilibrium is at **full employment level of employment**. The point is $(\bar{N}, \bar{w})$. This leads to potential real GDP $\bar{Y}$ (i.e there still can be natural rate of unemployment including structural and frictional unemployment while there is no cyclical unemployment).

   The model has drawback:

   - Real wages adjusting can be slow.
   - Matching people with job takes time.

4. **Outcomes**

   Full-employment GDP = potential GDP (same thing). Notation

   $$\overline{Y} = A * f(K, \overline{L})$$

   where A can be technology or productivity. So the increase of potential GDP can be caused by

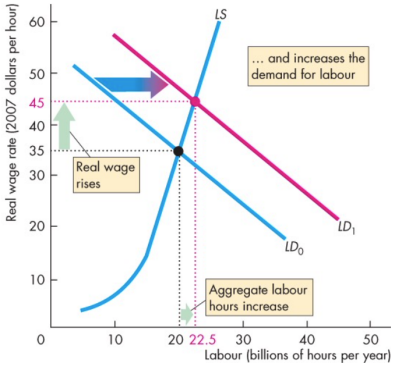
   - L ↑: This can be achieved by **average working hour per labour** ↑ or **employment to population ratio** ↑
   - A ↑: Technology or productivity
   - Working -age population growth

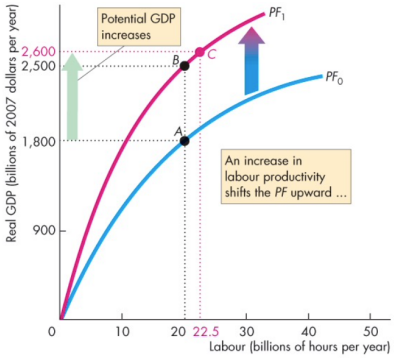
   To increase real GDP per captia, labour must be more productive.

   Question: Is population growth detrimental to GDP growth? with maothean theorem?

5. **Increase labour or labour productivity**

Let K fixed. In order to increase potential GDP, we can either increase L directly (i.e more employment by population growth or more hour per implement) or increase productivity of labour. The productivity shock and its outcome is below in two graphs. Following is an important



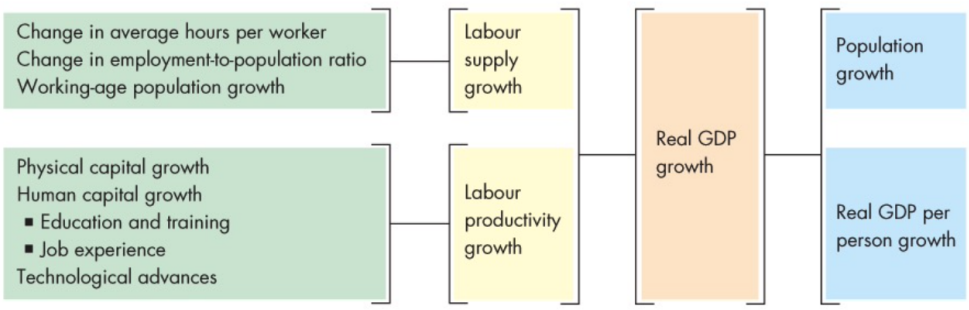


discussion. As productivity increase, some K, capital are replaced by labour. So labour demand shift to the right. As this raises the wages, more people get enter the labour market which leads to an increases in aggregate labour supply. This raises the real wages. The way this increase potential GDP is first, productivity shock shift PPF $PF_0 \rightarrow PF_1$ then point moves from A to B. Then as wages increases, more people enter the labour market which leads to increase of GDP from B to C. Also notice, as K $\uparrow$, MPK $\downarrow$ while MPL $\uparrow$.

Increase of productivity depends on **incentive system** and some precondition:

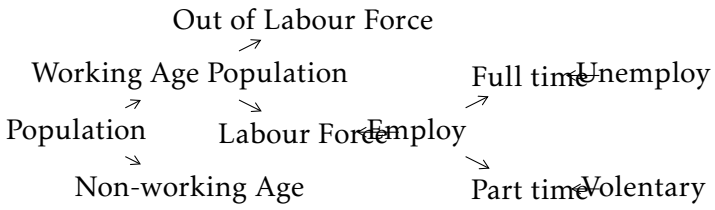
- Physical capital growth (better machine)
- Human capital increase (education enhancement, on-the-job training and most important is learn-by-doing)
- Technology advances

6. **Summary**



2.3 *Employment*

Unemployment results in **Lost incomes and production** and **Lost of Human Capital**. The construction of population, in terms of labour, is



Notice the different calculation of rates:

Unemployment rate = Unemployment/Labour Force

Employment rate = Employment/Working age Population

Labour Participation rate = Labour force/Working age Population

1. **Unemployment**

   The involuntary part-time rate is the percentage of labour force work part time but want full time jobs. Discouraged Workers/searchers is those who stop searching jobs due to lack of success at finding a job.

   There are three types of unemplouyment:

   - **Frictional**: People give up their original job and search for a new job. The time gap of employment cause the frictional unemployment.
   - **Structural**: Shrinking industry to growing industry. Competition among industry. Then cause the mismatch of skills.
   - **Cyclical**: The higher than normal unemployment at a business cycle trough and lower than normal unemployment at a business cycle peak. Computation is **Cyclical unemployment = actual - natural unemployment rate**

   2.1 DEFINITION. Full employment is the situation where there is no cyclical unemployment (i.e unemployment = natural unemployment = Fictional + Structural)

   Key factors influencing Natural rate of unemployment:

   - Age distribution of population
   - Scale of structural change
   - Real wage rate
   - Unemployment Benefits

GDP and Unemployment:Potential GDP is the quantity of GDP produced at full employment.

Output Gap: Real GDP - potential GDP = Output Gap

Take away: The relationship between GDP, unemployment rate.

2.4 *Long-run Growth Theory*

In this course we treat the output using the cobb-douglues production function with only two factors as input: Labour(L) and capital(K).

$$Y = A * f(K, L)$$

where in this case we have

$$Y = A * f(K, L) = A * K^{\alpha} L^{\beta}$$

and from ECON 301 we know

- $\alpha + \beta = 1$ means constant return to scales
- $\alpha + \beta > 1$ means increasing return to scales
- $\alpha + \beta < 1$ means decreasing return to scales

Then if we take to total derivative of Y we will find the growth accounting equations which is

$$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \alpha \frac{\Delta K}{K} + \beta \frac{\Delta L}{L}$$

by total derivative. So the growth rate becomes

$$g_y = g_A + \alpha g_k + \beta g_L$$

all g_is' are rate of growth measured in percentage changes. Also we notice the α and β can be interprated as the **elasticity of output w.r.p to capital and labour** respectively (i.e elasticity is the percentage change over percentage change). Then in terms of growth per labour we have

$$g_{Y/L} = g_A + \alpha g_{K/L}$$

where $g_{K/L}$ means the growth of capital labour ratio. From another perspective, treat the A as exgeneous in the model we have

$$\frac{\Delta A}{A} = \frac{\Delta Y}{Y} - \alpha \frac{\Delta K}{K} - \beta \frac{\Delta L}{L}$$

which is the residual. Let's assume constant return to scale (i.e this is a very common assumption). Then introduce the MPL and MPK

$$MPL = \frac{\partial}{\partial L} Y = (1 - \alpha) \frac{Y}{L}, \quad MPK = \alpha \frac{Y}{K} \tag{2}$$

while notice the derivation assume the other input is constant. This re-affirm that the diminishing return on labour can be caused by the fixed capital. Going forwad on this we check the condition that how does MPL goes when K is changing

$$\frac{\partial \text{MPL}}{\partial \text{L}} = \alpha(1-\alpha)\frac{\text{Y}}{\text{KN}} > 0$$

which is positive. So MPL increases when K is increasing. Same for MPK.Notice equation (2), if we assume MPL = Average production of labour, we will have $1-\alpha = (\text{MPL} * \text{L})/\text{Y}$. This shows α and $1-\alpha$ can be interpreted as the share of capital and share of labour used in production. Moreover, by the equivalence of expenditure and income approach, we can say α and α are the share of earning by labour and capital.

2.5 *Classical Growth Theory*

Core of Classical Growth Theory: Growth of real GDP per person is temporary and when it rises above the subsistence level, explosion of population will bring real GDP per person back to its subsistence level.

- Modern day Malthusians theorem is the supporting of classical growth theory which support the containing (control) of population.
- Population growth leads to decreases in real wages. Then population cont's to growth until subsistence real wage rate is achieved. At this stage both population and economic growth stop (steady state)

On the contrary, historical evidence shows population growth is not tightly linked to income per person and population growth does not driven back income to its subsistence level. So classical growth view population growth to be detrimental.

Limitation: Ignorance with respect to technology. Advancements in tech can minimize diminishing returns. Also the inaccurate determination of total wages. This means it ignore the role of trade union in wage determination.

2.6 *Neoclassical Growth Theory*

Core of Neoclassical Growth Theory: Real GDP per person growth since technology change induces a level of saving and investment that makes capital per hour of labour grow. (Notice the reason of technology advancement is not discussed in the growth theory, which means the A in cobb-douglas production here is exogenous.)

- Growth ends only if tech change stops and thus due to diminishing return to both capital and labour.
- Capital accumulation and economic growth are interrelated.
- Explains the factors affecting a nation's long-run standard of living.

- Demonstrates how economic growth evolves over time.

Neoclassical view population growth rate is independent of real GDP and real GDP growth rate. rate of technological change influence economic growth however economic growth has no effect on pace of technology growth. Some basic idea of neocalical:

- Technology advances more rapidly → New profit opportunities arise → investment and saving increases. Then together with tech changes→ Real GDP per person growth
- Results: Diminishing return to capital lower the real interest rate and eventually economic growth slows and just keep up with population growth. Capital per worker remain constant Technology stop to advance.

Assumption set up
Assume

- Population N_t is growing
- Share of working age population fixed at any time
- Population and work force grow at same rate n (i.e $g_N = n = g_{WF}$) which is
$$N(t) = N_0 e^{nt} r_0$$
where the rate is defined to be the relative rate $N'/N = n$.
- Closed economy and no government purchase
- Part of the output each year is invested in new capital or replacing worn-out capital (I_t, depreciation)
- The uninvested part is consumed which is
$$C_t = Y_t - I_t$$
Notice the investment includes depreciation. The stock of investment lead to the stock of capital. The stocked capital can depreciate. So in order to see the real growth in stock of capital, depreciation is necessary to be fixed by new investmente.

The Solow (-Swan) Growth Model: One of the Neo-classical model. The most detailed math version is in a separate pdf. We talk about the Per-worker Production function which is about the role of capital stock in growth model. Assume tech changes to be exogenous, we have

$$\underbrace{y_t}_{=Y_t/L_t} = A_t f(\underbrace{k_t}_{=Y_t/K_t})$$

where A_t is the level of total factor productivity in year t. The graph is still the same as before with dimishing return and positive slope. Actually the L_t should be considered to be in unit of hours.

A *steady state* is when the economy's y_t, c_t (consumption per labour) and k_t are constant, do not change over time. With out change in productivity A_t, steady state is reached in the long-run. Since y_t, c_t and k_t are constant in steady-state, then Y_t, C_t and K_t all grow at rate n, which is the growth of workforce. This can be thought to be $y_t = Y_t/L_t$. In order to keep y_t to be constant, L_t and Y_t should increase at same rate, which is the rate of growth of L that equals the rate of growth of population n.

Characteristic in Steady state: As stated before, the investment, consumption and capital per captia all remains constant. So

$$I = (n+d)k, \quad C = Y - I = Y - (n+d)k \tag{3}$$

and transform into per captia form we have

$$c = Af(k) - (n+d)k$$

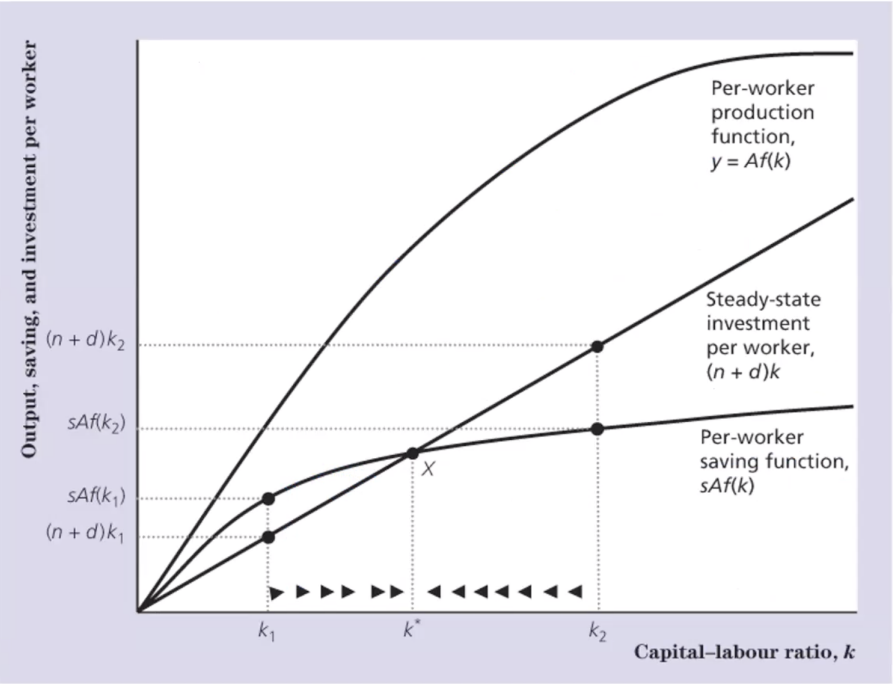
then recall the saving rate is constant so

$$S = s * Y = I = (n+d)K \implies \underbrace{sAf(k) = (n+d)k}_{sy(k) = i} \tag{4}$$

If we use cobb-doglous we have

$$k = \left(\frac{sA}{n+d}\right)^{\frac{1}{1-\alpha}}$$

which confirming with the detailed discussion below. The above discussion can be summarized into the graph below



2.7 *A detailed discussion about Solow-Swan growth model*

The model is trying to show that the accumulation of capital drives the economic growth and how this lead to a long run steady condition. In order to analyze how capital accumulates, we need to figure out input to stock of capital, how capital may get reduced and also a way to quantify the total production. Also in order to reflect the social welfare, all quantity is transformed to be in per captia form. So with this idea we have 3 building blocks:

1. **Production Function** We want to preserve the general law in economics which is the diminishing return which requires increasing but convex production function. More specifically, the Inada condition which suggests that the production function is definitely asymptotically the Cobb-Douglas production function (not quite accurate).

   Take the production function to be Cobb-Douglas with input labour and capital and easy to check

   $$\frac{\partial \mathrm{F}(\mathrm{K},\mathrm{L})}{\partial \mathrm{K}} > 0, \quad \frac{\partial^2 \mathrm{F}(\mathrm{K},\mathrm{L})}{\partial \mathrm{K}^2} < 0$$

   same for labour. Also assume constant return to scale. Then with scaled factor A, we define the production function

   $$\mathrm{Y} = \mathrm{A}(t)\mathrm{F}(\mathrm{K}(t),\mathrm{L}(t)) = \mathrm{A}\mathrm{K}^{\alpha}(t)\mathrm{L}^{1-\alpha}(t) \tag{5}$$

its per captia counterpart

$$y(t) = \frac{\mathrm{Y}(t)}{\mathrm{N}(t)} = \mathrm{A}k(t)^{\alpha}$$

The scaled factor $\mathrm{A}(t)$ is the total factor production which captures technology and, in a more broader sense, all those factors which are able to affect the factor efficiency in production. It is assumed to be exogenous. At this point, we assume A to be constant (i,e the model can use to analyze if A changes over time).

2. **Motion of Capital** Capital accumulate due to inflow of saving and investment while can be reduced due to depreciation. So we the motion of capital can be defined as

$$\mathrm{K}_{t+1} = \mathrm{K}_t + \mathrm{I}_t - \delta \mathrm{K}_t \tag{6}$$

for discrete time and for continuous time we have $\mathrm{K}(t + \Delta t) = \mathrm{I}(t)\Delta t - (1 - \delta\Delta t)\mathrm{K}(t)$, then do some algebra and take the limit we have

$$\mathrm{K}'(t) = \mathrm{I}(t) - \delta \mathrm{K}(t) \tag{7}$$

its per captia counterpart

$$k'(t) = i(t) - (\delta + n)k(t) \tag{8}$$

which is solvable ODE.

3. **Saving and investment** The model is not trying to capture the consumption-saving decision of individuals. Instead the constant ratio of saving is assumed (i.e in a Keynesian nature). Since economy is closed, saving equals investment. We express this as

$$\mathrm{S}(t) = \mathrm{I}(t) = s\mathrm{Y}(t) \tag{9}$$

Assume population growth to be $\mathrm{N}(t) = \mathrm{N}_0 e^{nt}$ and easy to check the constant relative growth rate is constant a. (Let the ratio share of labour force is also constant) Recall we assume constant ratio of WA population then the WF and WA are both growing at rate n in a relative sense. Then we are able to transfer all those quantities into per captia form. Finally we substitute

$$i(t) = sy(t) = s\mathrm{A}k(t)^{\alpha}$$

in to equation (6), we get the final model, the **Solow-Swan growth model** which is

$$k'(t) = s\mathrm{A}k^{\alpha}(t) - (\delta + n)k(t) \tag{10}$$

Notice what does this tell: Don't plug in the specific form of production function. It can be seen that

$$sy(t) = (\delta + n)k(t)$$

this suggests that in steady state, the saving per captia equals $(n + \delta)k(t)$.

Then to solve for steady state condition for each factor, we want equation (8) to be 0. This gives

$$k^* = \left(\frac{sA}{\delta + n}\right)^{\frac{1}{1-\alpha}}, \quad y^* = \left(\frac{sA}{\delta + n}\right)^{\frac{\alpha}{1-\alpha}}, \quad c^* = (1 - s)\left(\frac{sA}{\delta + n}\right)^{\frac{\alpha}{1-\alpha}} \tag{11}$$

where c^* is the consumption (recall the whole income goes to either consumption or saving). Notice that **capital** is a stock concept while saving/investment is a flow concept.

We need more interpretation for equation (10). The growth rate per captia depends on two factors: one is saving per captia and one is the 'effective' factor of depreciation. The negative correlated part includes the increase of population and the depreciation from existing accumulated capital. Notice the first part, saving per capita, have not yet get rid of the depreciation of capital. Also notice the positive part increases concavely while the negative part increase linearly so the affect of negative part will exceed the positive part at some point and that point is where steady state is achieved. The effective depreciation part can be thought as the used up capital.

The Golden Rule level of capital stock It is the level of capital stock that maximize consumption per worker. This is

$$\underset{k^*}{\text{argmax}} \; c^*(k^*) = \underset{k^*}{\text{argmax}} \; f_k(k^*) - (n + \delta)k^* \tag{12}$$

which has soltion

$$k_{\text{GR}} = \left(\frac{\alpha A}{n + \delta}\right)^{\frac{1}{1-\alpha}}$$

which is not the same as the steady state expression. Also notice the numerator is $\alpha * A$. This means the steady state consumption is not maximized as long as the saving rate is different from capital share. The theory shows that

- Economic policy focused on increasing capital per worker may do little to increase consumption possible possibilities
- However, empirical evidence shows higher capital stock does not lead to less consumption in the long run. **So we assume that an increase in the steady-state capital labour ratio raises steady-state consumption per worker.**

Implication of the model:

- Capital-labour ratio tends to go to k^* and remain there forever unless something changes.
- Long-run well being is measured by steady-state level of consumption per worker which is determined by *saving rate, population growth rate, rate of productivity growth (however in the noe model is assumed rather than explains it)*
- Higher saving rate implies higher living standard. Increased saving rate raises output at every level of capital per worker. Then a steady-state with higher consumption and output is attained in the longrun.
- Increase in saving rate lead to a fall in current consumption. So trade of between current and cunture consumption. So $k_{\text{GR}} \neq kss$ not necessary.
- Increased population lower living standard (same as Mothotian).
- Only continuing increases in productivity can perpetually improve living standard.

Convergence (of countries to steady-state)

- Unconditional convergence: All countries over the world will converges to the same living standard.
- Conditional convergence: Only countries with similar conditions converges.

For endogenous growth model, the setup of the model may leads to non-diminishing capital return which explodes growth, no steady state is achieved.

3 FINANCE, INVESTMENT AND SAVING

Some definition need to be introduced:

- Study of finance looks at how households and firms obtain and use financial resources and how they cope with risk
- **Physical capital:** Tools, instruments, machines,buildings. Produced in the past.
- **Financial capital:** Cost is the opportunity cost like interest. Funds used to purchase physical capital.
- **Wealth and saving:** Wealth is a stock concepts while saving is the amount of income less tax and consumption. Notice **To increase wealth, income does not have to increase (i.e wealth can go up itself like investment etc. which is the capital gain.)**

- **Marginal Propensity to Consume (MPC):** The proportion of disposable income that is consumed. So the relationship between saving and disposable income can be interprated as

$$S = Y_D - C = Y_D \ * \ \textbf{MPC}$$

so to increase saving, one can either increase MPC or increase its disposable income and then increase your wealth. Notice you should state explicitly assume MPC is constant. The desired consumption is not just a list of what consumers and firms would buy if they had no constraints on their spending — it is much more realistic than that. Desired expenditure is what consumers and firms would like to purchase, given their real-world constraints of income and market prices.

- Main source of funds are from **loan market, bond market** and **stock market** which are all determined in supply and demand.

- The net worth of a financial institution's net worth is the total market value of what is has lent minus the market value of what is has borrowed. If net worth is positive then it is solvent otherwise not.

Then the we talked about the financial institutions. First, There are several sources of funds that finance investment comes from: **Household saving or the private savings S, Government budget surplus or the government savings (T-G), Borrowing from abroad (IM-X)**. The statement is proved below

$$Y = C + I + G + (X - IM)$$

$$\underbrace{Y - T - C}_{Y_D - C = S_p} = I + \underbrace{(G - T)}_{S_g} + (X - IM)$$

$$I = S_p + S_g + \underbrace{(IM - X)}_{\text{Capital Inflow}}$$

Notice the last term means net export is the money borrowed. This is because, if a country import more than it export, this means that the rest of country around the world hold more its currency and these money will eventually be invested to it. So in short, **more import is a lender, more export, borrower (of money, capital).** Then again the formula for nominal and real interest rate

$$1 + i_{\text{Nominal}} = (1 + i_{\text{Real}}) * (1 + e^{\pi}) \tag{13}$$

where π is the inflation rate. **The real interest rate is the opportunity cost of borrowing.** When discounting the future value and view it from an opportunity cost view, the rate is the **real** interest rate.

3.1 *Consumption and Saving*

Consumption accounts for 60% of total spending. Consumption and saving are linked closely. The desired national saving it the level of national saving that occurs when consumption is at desired level. So

$$S_d = Y - C_d - G = I$$

Notice the S_d is National desired saving while C_d is private sector (households) desired consumption. Goverment has no so-called desired consumption. Here comes a concept of **life time budget constrain.** Omitted here. The **consumption-smoothing motive** means two things: We want to consume in the future at least (more or equal) what we are consume today. Think of the life time is consist of two parts. Let's use the subscript 1 and 2 for this. Assume in the second period you don't earn any income. So

$$Y_1 = C_1 + \frac{C_2}{(1+r)}$$

We can consider C_1 and C_2, the consumption in the two period, as a 'weight' so that people consider how much to save.

The quantity of (current) loan-able funds supplied depends on

- **Current income:** Depend on MPC. If constant, then earn more also save more so then Q increases.
- **Expected future income:** If increase, current saving decrease.
- **Wealth:** If wealth increase, assume this is a on-time increase increase, then people save less. This is a bit tricky. We consider that people save money in order to increase there wealth and the reason to increase wealth is exogenous. Let the wealth increase (may be due to lottery) once. Then people need less than usual amount to save in order to achieve its usual saving amount. So they spend more on consumption. Recall the **consumption smoothing motive** they then shift to save less forever.
- **Default risk:** Default risk increase, saving decrease.
- **Real interest rate:** Real interest rate increase, saving increases (moving along the line). For lender (savor) this has to effect
  - The opportunity cost of consumption increases, so C decrease and S increases (**Substitution effect**)
  - Current income from wealth increase increases so current consumption increase and therefore decrease current saving (**income effect**)

  So notice when we draw the supply curve of r, the real interest rate and Q, the quantity of lending available, we are implicitly assuming that the

substitution effect > income effect. For borrower, both SE and IE leads to increases in S. For SE, since cost of borrowing increases. For IE, consider the borrower still need the certain amount of money, so borrower pump in more of it income into saving. not very mature thought.

- **Tax rate in interest:** Tax rate in interest increase, save less (real interest rate drops). So the approximated after interest tax return is

$$r_{a-t} \approx (1-t)i - \pi^e$$

where π^e is the expected inflation. The exact one is

$$r_{a-t} = \frac{(1+i)(1-t)}{1-\pi^e} - 1$$

This shows that, **by reducing tax rate, the real rate increases and then could possibly increase the rate of saving.**

- **Fiscal policy (Government purchase and tax):** Consider (T − G) and apparently you know S_{total} moves due to S_G. Let aggregate output Y is given and fixed, not affected by changes in fiscal policy.

3.1 EXAMPLE. (About Fiscal Policy Changes) Analyze G ↑. We first recall the definition we have before:

$$S_d = Y - C_d - G = \underbrace{S_{p,d}}_{Y-T-C} + \underbrace{S_g}_{T-G}$$

where the second equality is easy to check by ±T on the RHS simultaneously. First, G ↑ lead to $C_{p,d}$ ↓ due to expected higher tax and the con-sequencing Y_D. Then $S_{p,d}$ ↑ consequently. Then from government perspective we have S_g ↓. Empirically, the decrease in S_g dominates. How the Y is kept constant? Not able to derive Notice if the G ↑ leads to a government deficit, it will probably issue bonds to raise money and may also impact demand on it later. Case for T ↓ is similar analysis but don't know how saving goes exactly.

3.2 THEOREM. *(Ricardo-Barro Equivalence) Consumers are forward-looking and so internalize the government's budget constraint when making their consumption decisions. So the method of financing such spending does not affect agents' consumption decisions, and thus, it does not change aggregate demand*

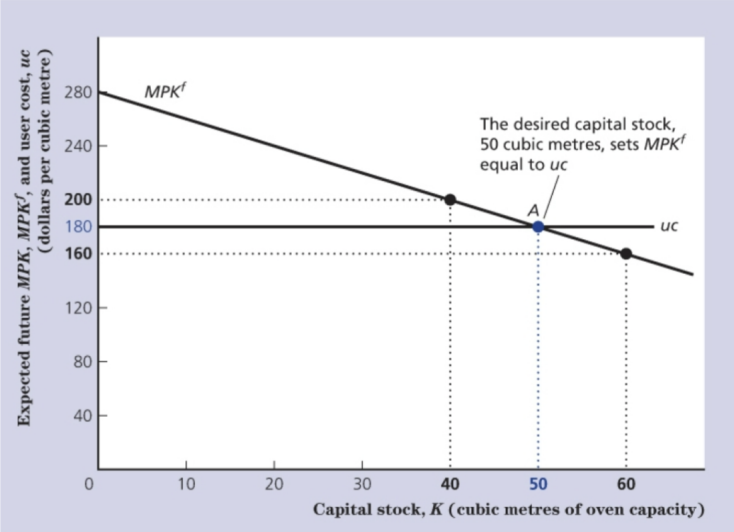
The application of the theorem is that, when G ↑ or T ↓, people will forward-looking this to be reversed (i.e G ↓ or T ↑) in the future so the S_g ↓ and G ↑ will cancel out.

Then we move to the demand side of loanable funds. The Desired capital stock is an amount of capital that allows firms to earn the largest expected profit.

The firms benefit is MPK^f, the future MPK. The firm's cost is the user cost of capital (in finance is the cost of raising money). In econ we defined it to be

$$uc = r * p_k + d * p_k = (r + d)p_k$$

where uc is the user cost of capital, r is the expected rate of interest, d is the rate at which capital depreciates and p_k is the real price of capital goods. The desired capital stock is the capital stock exactly where $\text{MPK}^f = uc$. The scenario is simply. A machine is bought by money borrowed from bank. Then the cost comes from two sources: one is the interest of money borrowed and one is the depreciation of physical machine.



Very basic idea of maximization (i.e MC = MP). Know how to solve

$$\text{MPK}^f = uc$$

Notice when r or d decreases, the uc curve shift downward and thus a higher desired capital. When technology improves, MPK curve shift up. If we consider tax, then we should solve

$$\text{MPK}^f = \frac{uc}{1-t}$$

which means $\text{MPK}^f(1-t)$ is the real after tax revenue. So the above equation suggests a upward shift of original uc.

Then recall the solow model (same idea), a firm's gross investment during the year has two part

$$\text{I}_t = \text{K}^* - \text{K}_t + d\text{K}_t$$

where K^* is the desired capital stock in the next period $(t+1)$.

3.2 *A insertion: Goods Market Equilibrium*

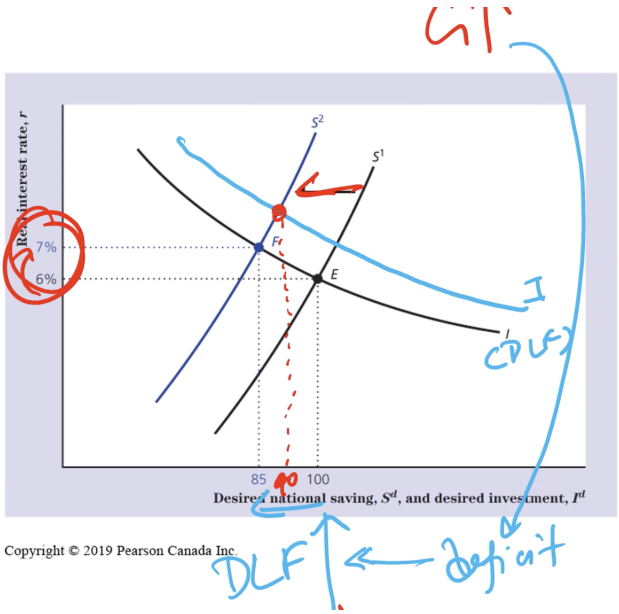
Let's assume again the closed economy. The goods market equilibrium condition is

$$Y = C_d + I_d + G$$

This is reached by let the $S_d = Y - C_d - G = I_d$. This is **desired national saving = desired national investment**

3.3 *Crowding out of investment*

Consider government increases G. By previous discussion we know that S_d decreases due to the $S_g \downarrow$ ¿ $S_p, d \uparrow$. Then the SLF curve shifts to the left and the equilibrium r goes up.



The above argument is shown by the shift of S^1 to S^2. Then recall that if the increase in G leads to a deficit for government, then government need to issue bonds which then increase the demand of lonable fund which is shown as the shift of curve I. The decrease from 100 to 85 is due to $S_g \downarrow > S_p \uparrow$ and then from 85 to 90 is due to $S_p \uparrow$ which increase private savings since money from households goes to by government issued bond. This is the crowing out effect that government crowding out money from private sector.

Also the investment curve can shift. For example due to innovation or economic reform raises MPK^f so there is more investment (i.e the x axis in MPK and uc graph).

4 NATIONAL BALANCE OF PAYMENTS ACCOUNTS

Export +, import -. The balance of payment is the net increase in a country's official reserve assets (i.e official reserve assets increase when balance of

payment has surplus. Notice

- The current account balance and the capital account balance must sum to zero at each period of time (CA + KA = 0) under flexible exchange rate regime (i.e you need OR account to manipulate the currency value). The KA is without OR, official reserve.

- The statistical discrepancy sis the amount to be added to the sum of CA and KA balances to reach its theoretical value of zero.

- Let M – X > 0 then this means the CA is negative and (i.e import more than export).

A small open economy can not affect the world real interest rate. So in the long-run, the economy will adjust there interest rate equal to the world interest rate. In an open economy, $S_d = I_d$ not necessary.

4.1 EXAMPLE. A Canadian bought a U.S company bond (i.e apple) and earn a dividend. This is under NFP in current account. However when he buy this bond, its under capital account.

In open economy, the good market equilibrium is given by

$$S = I + CA = I + NX + NFP$$

where we assume the NFP = 0. Then

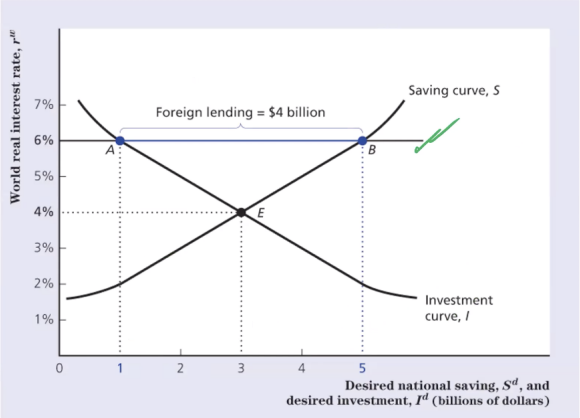
$$NX = Y - \underbrace{(I^d + C^d + G^d)}_{absorption}$$

the absorption is the total spending of domestic residents.

5 CASE FOR OPEN ECONOMY

For a small open economy the international interest rate is fixed. In the long run, the supply and demand will shift and move to the new equilibrium rate of the world. In the short run, we assume that the government fixes the rate at a certain level, for example

FIGURE 5.2
A SMALL OPEN ECONOMY THAT LENDS ABROAD
The graph shows the saving–investment diagram for a small open economy. The country faces a fixed world real interest rate of 6%. At this real interest rate, national saving is $5 billion (point *B*) and investment is $1 billion (point *A*). The part of national saving not used for investment is lent abroad, so foreign lending is $4 billion (distance *AB*).

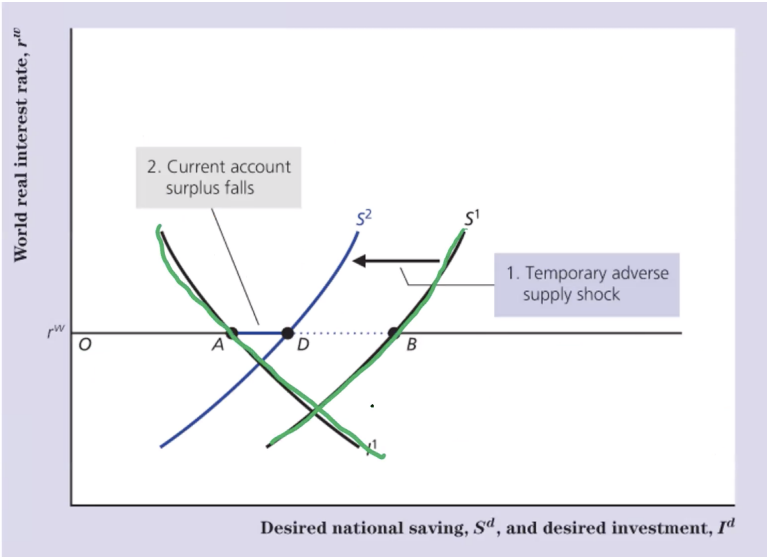


the world interest rate i^w is at 6% and the economy's government set the domestic interest rate at 4%, so at 6% the I^d and S^d are points A and B respectively. This gives us a way to look at desired investment and saving which is the S and I at a given interest rate. So we see the $I^d < S^d$, supply greater than demand then the economy becomes a lender: lend out the money to the rest of the world and the quantity is $S^d - I^d$.. Similar logic when $i^w < i$.

5.1 FACT. $S^d - I^d = NX$. So any change that increase S^d at a given world real interest rate r^w will increase net lending, CA balance and Net export.

5.1 *Shock for Small Economy*

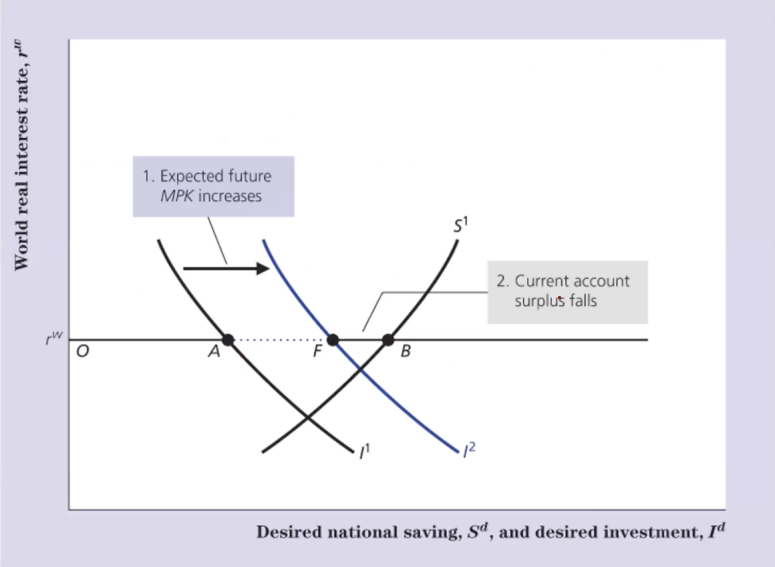
Temporary Supply shock For example, assume CA > 0 before the drought occurs. Then there is a sever drought: The drought is a supply related constrain. So the investment demand is not effected. While income falls, keeping MPC fixed the case become



where S_1 is the initial saving. Drought occurs and shift the saving. So the NX decrease by the amount of B-D. Notice the equilibrium is a long-

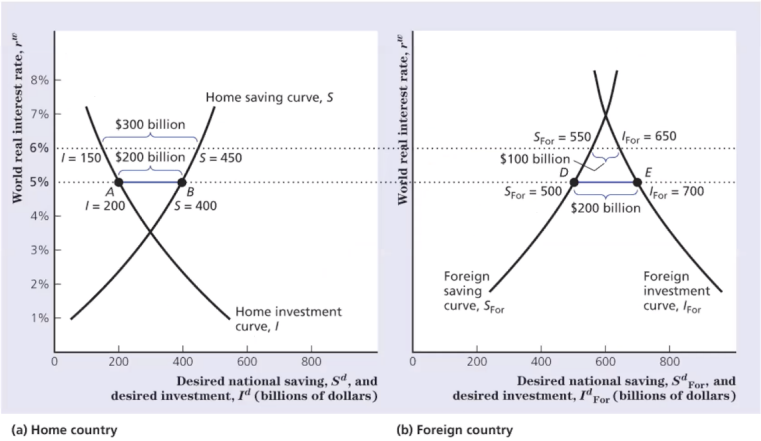
run equilibrium since the interest rate does not change. Compare this to the classical SAS, LAS and SD model. That model can reverse due to the flexibility of price. However in our case here the 'price' is actually interest rate which is kept constant so it will stay there. Most temporary supply shock will effect the saving.

Permanent Positive Supply Say technological innovation when the CA is in surplus: Technology innovation increase the *marginal production of capital (MPK)* known from last chapter. So investment shift case become



5.2 *Case for Large Economy*

We assume there are two economy: the Domestic and the Foreign Economy. Not a good assumption actually. The case is



At i = 5% is the initial equilibrium, where we start from where domestic lends out 200 and foreign borrow these 200. As i increases to 6%, domestic lends 100 more. Notice the 6% is not equilibrium while the 5% case is the long-run

equilibrium we start with and will finally returns to. The increase to 6% can be thought as one time of fluctuation of a supply and demand of loanable fund between two countries.

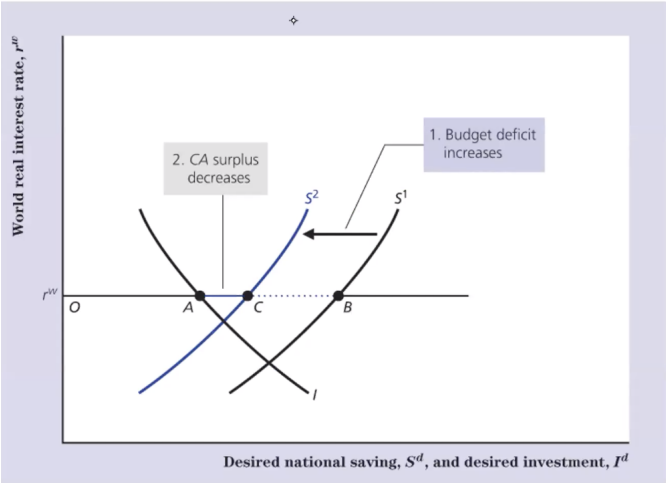
Twin deficit This means trade deficit and budget deficit at same time. This is

$$S_p = I + (-S_g) + NX$$

where $S_g < 0$ and $NX < 0$. An increase in government budget deficit will raise the current account deficit only if the increase in budget deficit reduces the desired national savings. This means $S = S_p + S_g$ decreases. So, for small economy

$$S_p + S_g \downarrow \longrightarrow S \downarrow \longrightarrow NX \downarrow = S - I = \textbf{Lending} \downarrow$$

so it likely to be a net borrower (i.e lending goes to negative) and the graph



However, if we consider the Ricardo effect, the above is LESS likely to hold since the decrease in S_g , either caused by tax cutting or spending expansion will lead to higher saving.

6 ASSET MARKET, MONEY AND PRICE

Asset market is the trade involves real asset (i.e hoses, gold) and financial assets (i.e stocks, bonds). Money is also asset and we assume the bond and money as substitutes in this course. Function of money are **medium of exchange, store of value and unit of account**. *Liquidity* is the property of being instantly convertible into a means of payment with *little loss of value*. Deposit is money money while cheque is not.

6.1 *Portfolio Allocation and demand for Assets*

The portfolio allocation decision is based on **Expected return, risk, liquidity, time to maturity** of an asset (i.e any asset).

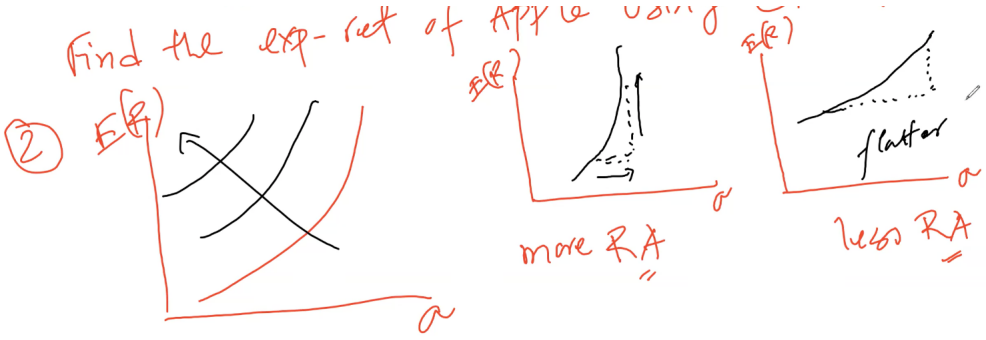
Expected rate of Return: For example, expected RR on stock = Dividend yield + capital gain yield. The famous equation is

$$\mathbb{E}(R_i) = \textbf{Riskfree Rate} + \beta_i(\textbf{market risk premium})$$

where β_i is a measure of market risk or systematic risk of stock i.

Risk and Liquidity: High risk if the actual return has a significant chance to be different from the expected return. We are assuming that an individual is risk-averse. This contains two types of people: Risk lover (i.e same return, chose the more risk one). The other one is that there is risk premium.

The risk aversion people: Same return, pick the one with lower risk; same risk, pick higher expected return. So risk aversion people not chose to minimize risk. The following graph shows the different indifference curve for risk averse and preferred



So risk averse people has a steeper curve.

Time to Maturity The expectation theory assume that the bonds of different maturity are perfect substitute. Another theory called liquidity preference theory which says long term and short term bonds are not perfect substitution and the long term bond should give more premium as compensation.

Duration Measure of interest rate risk for bond, similar to elasticity.

$$Duration = \frac{\&\Delta\textbf{Price}}{\%\Delta i}$$

Then, since the long term bond prices are more sensitive to changes in market interest rates, they have higher interest-rate risk (i.e higher duration). Together with expectation theory and term premium explain the upward slope of yield curve (i.e yield of a bond v.s maturity). A inverted yield curve is a sign of recession.

Risk-return trade-off means higher expected return comes with higher risk. Real returns are much more stable than nominal since inflation was very volatile.

Money Demand of money. Effected by **price level(+), income(+) and**

interest rates (-). Here comes the money demand

$$M^d = P * f(Y, i)$$

$$M^d = P * f(Y, r + \pi^e)$$

where P is price level, π is inflation, r is real interest rate. Real money demand becomes

$$\frac{M^d}{P} = f(Y, r + \pi^e)$$

The reason why people hold more money as income (Y) increases is that they would like to consume and buy more. Transaction, speculation and precaution demand for money.

Elasticity of Money Demand Remember the relation of M^d is given by Y, i, P then the elasticity can be represented for each of them by

$$E = \frac{\%\Delta M^d}{\%\Delta Y/i/P}$$

where the elasticity for income is about 0.5 and for interest rate is about -0.3.

Some other factors affecting money demand are **Higher wealth, higher riskiness of alternative asset and lower liquidity of alternative assets.** Debates on higher efficiency of payment technologies have effect. This means more ways of making payments so money demand reduces. Or higher efficiency means more transactions on average so money demand increase. Banks not opening quick in covid. They don't want people to take out money right away (efficiency)

Quantity theorem of Money This means

$$MV = PY$$

where M is the quantity of money, V is the velocity, P is price and Y is real GDP. So

$$\%\Delta M + \%\Delta V = \%\Delta P + \%\Delta Y$$

Here in our case, let assume

$$\frac{M^d}{P} = kY, \;\; k = 1/v$$

where the $L(i, Y) = kY$ which is a strong assumption that L does not depends on real interest rate and k is a constant. This asserts that real money proportional to real income. Notice the way we interpret velocity can be

$$V = \frac{PY}{M}$$

which is how many times a dollar changes hands. We can combine two theory together: the QTM and Money demand and solve for velocity.

6.2 *Asset money Equilibrium*

Sum of all individual demands equals total nominal wealth. We divides the whole assets into **non-monetory and monetory assets**. So

$$M^d + NM^d = \text{Aggregate nominal demand} = \text{a. nominal supply} = M^s + NM^s$$

Further, divide these into two markets, the NM and M. So as one market in equilibrium the other will be in equilibrium simultaneously. M^s is the **fixed** supply of money and NM^s is **fixed** supply of NM assets. The equilibrium condition is

$$(M^d - M^s) = (NM^d - NM^s)$$

so as long as the LHS is 0, both market will be in equilibrium (i.e $M^d = M^s$). Then together with previous results

$$\begin{aligned} \frac{M^s}{P} &= f(Y, r + \pi^e) \\ P &= \frac{M^s}{f(Y, r + \pi^e)} \end{aligned} \tag{14}$$

The lecture PPT and logic is garbage. Summary it here: Money demand is determined as

$$\frac{M^d}{P} = f(i_{\text{nominal}}, Y_{\text{real}})$$

and money supply side is simply determined by the central bank so the real side of M^s is just M^s/P. Then we consider the QTM which is $MV = PY_{\text{real}}$. This equation works for both M^s and M^d (i.e this simply gives a relationship to describe the quantity of money in the market.) so

$$\underbrace{\frac{M^s}{P} = \frac{1}{V}Y}_{\textbf{supply side}} = \underbrace{\frac{M^d}{P} = f(i_{\text{nominal}}, Y_{\text{real}})}_{\textbf{demand side}}$$

then we can solve for velocity. Notice the Y_{real} and $i_{nominal}$ ar determined by equilibrium in the labour and goods markets, price P is determined by the asset market equilibrium condition (also the good market). Using $M^s/P = f$ then the money growth and inflation can be derived as

$$\underbrace{\frac{\Delta P}{P}}_{\textbf{growth rate inflation}} = \underbrace{\frac{\Delta M}{M}}_{\textbf{growth rate money supply}} - \underbrace{\frac{\Delta f(Y, r + \pi^e)}{f(Y, r + \pi^e)}}_{\textbf{growth rate REAL money demand}}$$

With this equation, in the long-run equilibrium with a constant growth rate of money, the nominal interest rate will also be constant.don't understand
Thus the rate of inflation in a full-employment economy also depends on

the percentage change in real income (i.e $\Delta Y/Y$) and the income elasticity of money demand η_Y

$$\pi = \frac{\Delta M}{M} - \eta_Y \frac{\Delta Y}{Y}$$

where η_Y is

$$\eta_Y = \frac{\%\Delta M^d}{\%\Delta Y}$$

7 BUSINESS CYCLES AND IS-LM-FE MODEL

Keynesian economists argues wages and prices adjust slowly, so there can be sustained recession and we should solve it.

Twoimportant characeristics of cyclical behaviour:

- Direction in which a macro economic variable moves relative to the direction of aggregate economic activity.
- The timing of the variable's turning points relative to the turning point of the business cycle.
- A procyclical variable moves in the same direction as aggregate economic activity.
- A countercyclical variable moves in the opposite direction to aggregate economic activity.
- An acyclical variable does not display a clear pattern over the business cycle.
- A **leading** variable's turning points occur before those of the business cycle.
- A **coincident** variable's turning points occur around the same time as those of the business cycle.
- A **lagging** variable's turning points occur later than those of the business cycle.

For example **production** is a coincident and pro-cyclical. **consumption, fixed investment** are procyclical and coincident, but consumption of **durable goods and residential investment** are strongly procyclical. Export expenditures are a reflection of foreign business cycles and business cycles are often transmitted between countries through the trade balance.

Unemployment rate is strongly countercyclical and coincident. GDP data is lagging. Average labour productivity tend s to be procyclical and leading. Rate of monetary growth is procyclical and leading. Inflation is procyclical but lagging. Stock price is procyclical and leading. Nominal interest rates are procyclical but lagging. Real interest rate is acyclical.

IS-LM Investment, saving, money demand, money supply. This model can be used to represent both classical and Keynesian model.

Note