Macroeconomics

Principles of macroeconomics

Macroeconomics studies the structure of aggregate economies and the impact of policies on their performance. Includes business cycles, economic growth, unemployment, inflation, monetary and fiscal policies, etc.

Cyclicity is a periodicity in economic factors growth (i.e. GDP), the periods of expansion (typically, longer) and recession.

Recession = two or more quarters of negative GDP growth. (Rule of thumb, not always the case)

Introduction to Macro Data

Gross domestic product (GDP), or Produit interieur brut (PIB)

GDP is the market value of all final goods and services newly produced on domestic soil during a given time period.

> *– Why do we care about it?*
>
> *– It is correlated with factors we care about such as standard of living, wages, unemployment…*

How to measure GDP (we note it Y)? Three ways:

1. **Total production** = Sum of value added across all firms.
2. **Total income** = Labor income + Capital income + Government income
3. **Total expenditure** = Consumption (C) + Investment (spending by business) (I) + Government spending (G) + Net export (NX).

Fundamental identity:

$$\text{Total production} = \text{Total income} = \text{Total expenditure}$$

Example:

1. A company buys raw material for R\$.
2. It pays wages to the guys working there W\$ and taxes to government T\$.
3. It sales the product to the final user for P\$.

Here

1. Production = Value added = $(P - R) + \overbrace{R}^{\text{someone produced it}} = P.$
2. Income = $W + T + \overbrace{(P - R - W - T)}^{\text{company profint}} + R = P.$
3. Expenditure = P.

We will work with the expenditure approach:

$$\underbrace{Y}_{\text{supply}} = \underbrace{C + I + G + NX}_{\text{demand}} \tag{Y}$$

> ***Classic economist:***
>
> *"Prices and wages adjust immediately to attain equilibrium."*
>
> ***Keynesian economist:***
>
> *"Sticky prices and wages adjust slowly and cause unemployment. Thus, proper monetary policy is required."*

Savings

Savings = Current income - current needs

$$S := \text{National savings} = S_{HH} + S_G$$

Here S_G are governmental savings and S_{HH} are household savings.

New characters: Transfers (Tr) (like welfare), disposable income Y_d. For households disposable income (we ignore business savings completely here!) is given by

$$Y_d = Y - T + Tr = C + S_{HH}.$$

Government savings $S_G = T - G - Tr$. So,

$$S = Y - G - C \overset{(Y)}{=} I + NX$$

Inflation

Problem: GDP today in tomorrow are measure in “dollars of today” and “dollars of tomorrow”.

To observe the changes in the goods produced one should normalize it by the *price index* $P(t)$ and look at the “real” GDP measured at the same level of prices

$$\text{Real GDP}(t) = \frac{\text{Nominal GDP}(t)}{P(t)}.$$

How to measure $P(t)$? For example, as a cost of a fixed basket of goods $P(t) \approx \sum_g w_g p_g(t)$.

Examples

1. CPI = consumer price index.
2. GDP deflator := $\dfrac{\text{Value of Current Output at Current Prices}}{\text{Value of Current Output at Base Year Prices}}$.

Inflation during the period Δt := $\dfrac{P(t+\Delta t) - P(t)}{P(t)}$.

We will assume that all the quantities used further are real.

The supply side of the economy

The *production function* $F(K, L)$: we suppose that GDP depends on capital (K, often replacement cost of capital) and labor (L, often number of workers or hours worked):

$$Y = A \cdot F(K, L)$$

Here A is a *Total Factor Productivity* (TFP) = index of efficiency in the use of inputs (In fact, regression residue…)

We also suppose that:

- $F(\cdot, L)$ is increasing and concave. Consequently, *Marginal Product of Capital* (MPK) $\partial_L Y$ decreases in K.
- $F(K, \cdot)$ is increasing and concave. Consequently, *Marginal Product of Labor* (MPL) $\partial_L Y$ decreases in L.
- Scaling property: $F(\lambda K, \lambda L) = \lambda Y$. That is why for Cobb–Douglas we will have $\alpha + (1-\alpha) = 1$.
- The higher K, the higher $\partial_L Y$. The higher L, the higher $\partial_K Y$.
- *Elasticity* in labor = $\dfrac{dY/Y}{dL/L} = \dfrac{\partial_L Y}{(Y/L)} \approx 0.7$. *Elasticity* in capital = $\dfrac{dY/Y}{dK/K} = \dfrac{\partial_K Y}{(Y/K)} \approx 0.3$.

Example Cobb–Douglas function $Y = AK^\alpha L^{1-\alpha},\ \alpha \in (0,1)$.

$$\partial_L Y = (1-\alpha)A(K/L)^\alpha, \quad \partial_K Y = \alpha A(L/K)^{1-\alpha}$$

Elasticities:

$$\frac{dY/Y}{dL/L} = (1-\alpha), \quad \frac{dY/Y}{dK/K} = \alpha.$$

The function satisfies all the assumptions for $\alpha \approx 0.3$.

Historical validity?

The Labor Market

Demand side

We suppose that market is competitive and a firm can

- Sell as much products Y as it wants at the price p.
- Hire as much L as it wants at the wage w.

Profit maximizing firm will hire L_d (labor demand) such that MPL $\partial_L Y = \dfrac{w}{p}$ (as a first order condition for $Y(K,L)p - wL \to \max$). L_d is a decreasing function of w.

Supply side

For the household there are two goods consumption C and leisure F. It can spend unit time working (L) either working or having fun (F), so $L + F = 1$. The budget constraint is then $wL = pC = w(1 - F)$ and the optimization problem is

$$\max_{pC+wF=w} U(C,F)$$

So, the price of fun is foregone wage $p(F) = w$. Optimality condition in terms of marginal utilities:

$$\frac{\partial_F U}{\partial_C U} = \frac{w}{p}.$$

If $\dfrac{w}{p}$ increases,

1. **Substitution effect**: you substitute leisure by consumption => need to work more!
2. **Income effect**: higher wages => you are richer => you will consume more C and F at the same time. Moreover, to consume the same amount of F, you need to work less.

We can also introduce *Present Value of Lifetime Resources* (PVLR). Income effect = increase of PVLR. Higher PVLR induces to work less. For a fixed PVLR, L_s is an increasing function of w.

Empirical fact: with equal (%) increase in PVLR and after-tax wage L_s falls, so income effect dominates.

IS-LM model

Goal: modeling the relationship between GDP Y and interest rate r considering goods market and money market equilibrium.

IS curve (investment–savings), demand side of economy

Goods market:

$$\underbrace{Y}_{\text{supply}} = \underbrace{C + I + G + NX}_{\text{demand}} \tag{IS}$$

- C is a function of PVLR, tax policy, expectations, etc.

- I is a function of r, K and investment tax policy.
- G is a function of government policy.

Monotonicity of $Y(r)$? When r decreases, I and C increase. So, $Y(r)$ is decreasing.

Why IS? We can consider separately $I(r)$ and $S(r) = Y(r) - C - G$ as two curves. At the equilibrium $S(r^*) = I(r^*) + NX$. So, we consider only the dependence $Y(r)$ given by (Y).

How to shift IS curve? Change C, I, G, NX

- Higher expected income –> higher PVLR –> higher C.
- Higher business confidence –> higher I.
- Higher G.

LM curve (liquidity–money), supply side of economy

Money market:

$$\frac{M_s}{P} = L_d(Y, r + \pi^e). \tag{LM}$$

Here

- M_s is *Money* supply, decided by Fed, does not depend on r.
- P is a price index
- r is a real rate, π^e is an expected inflation. $(r + \pi^e)$ is nominal interest rate.
- L_d is a function that determines real money demand a.k.a. *liquidity*. Decreasing function of r, increasing function of Y (transaction demand -> demand for money).

LM curve: for other parameters fixed, when Y increases r increases too.

IS-LM equilibrium is a point (r^e, Y^e) of intersection of these curves. It is a <u>short-run equilibrium</u>, firms are ready to hire more workers.

<u>In the long-run</u>, prices will change until the equilibrium in the labor market (all the workers seeking for a job find a firm proposing it):

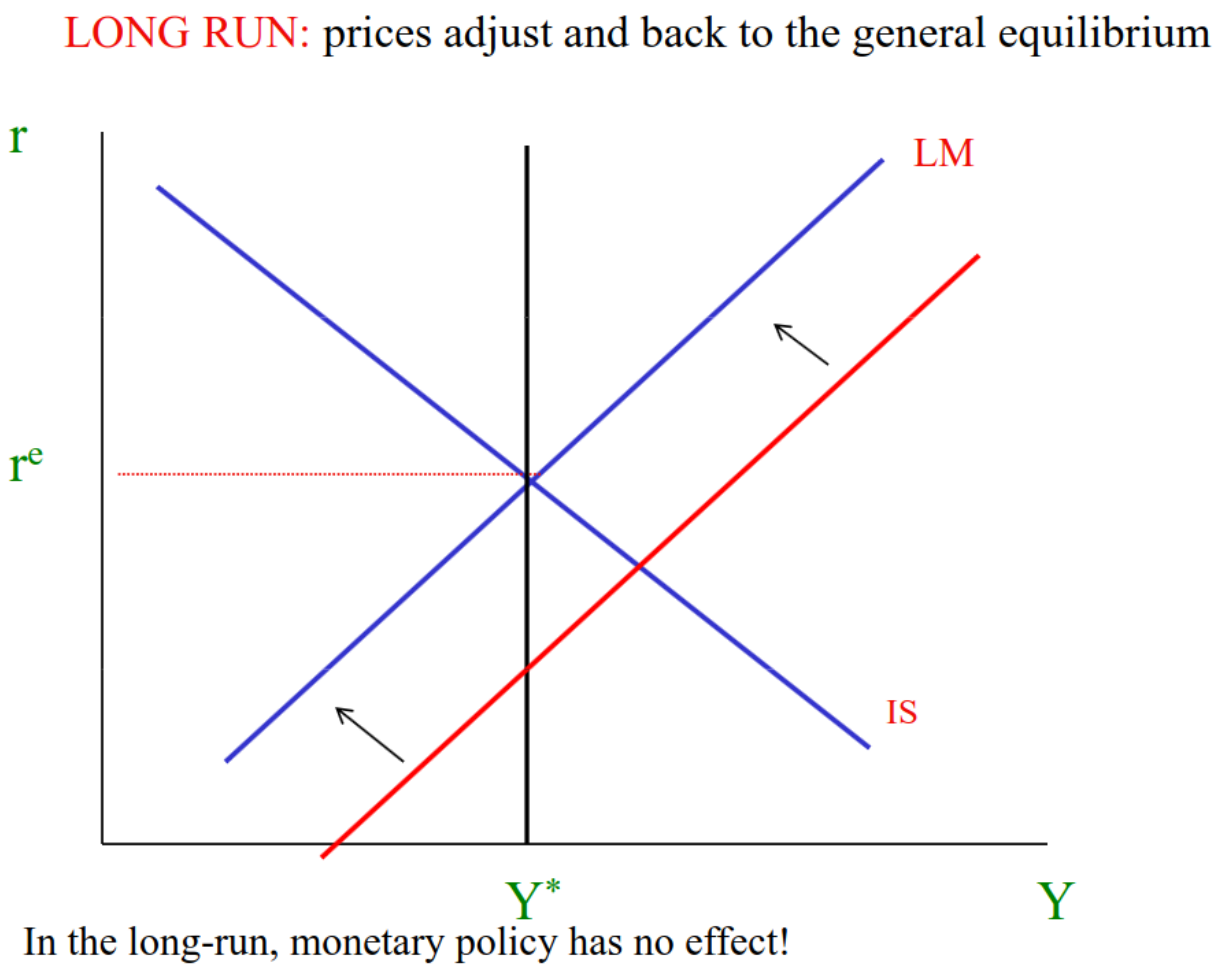
$$Y^* = A \cdot F(K, L^*) \tag{FE}$$

FE-curve is not sensitive to r, describes long run equilibrium.

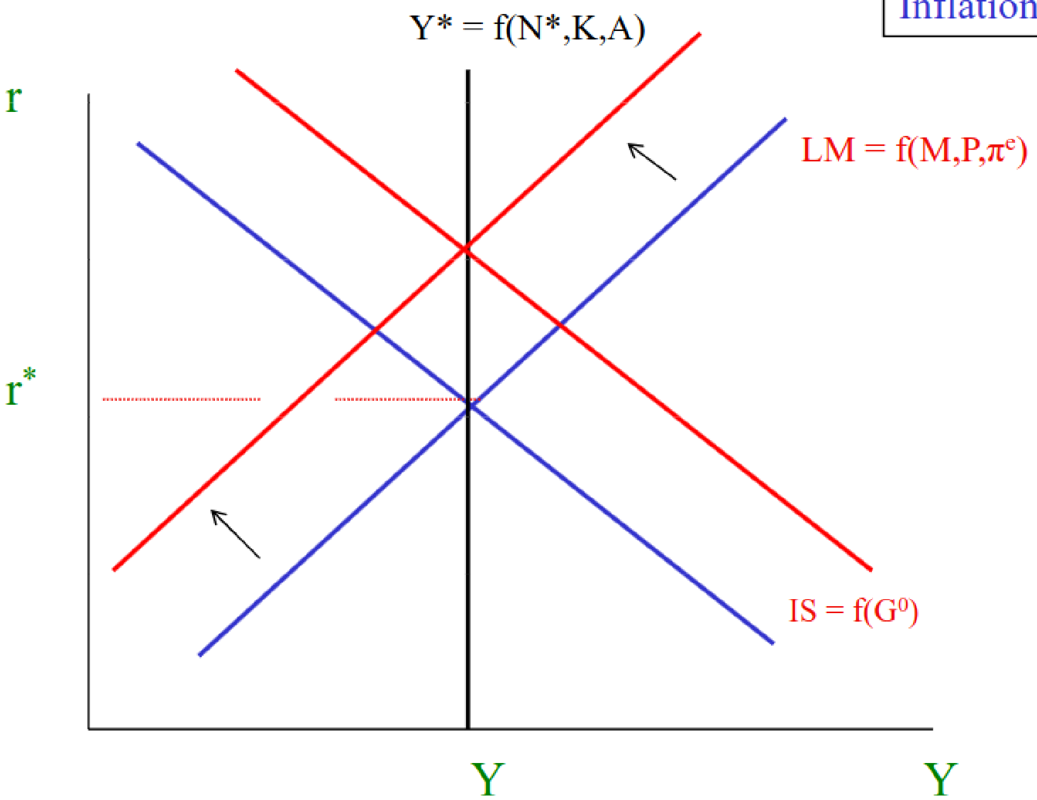
Conventional definition:

- Short run — prices are sticky
- Long run — prices adjust in order to match (FE).

Monetary policy = control of M_s.

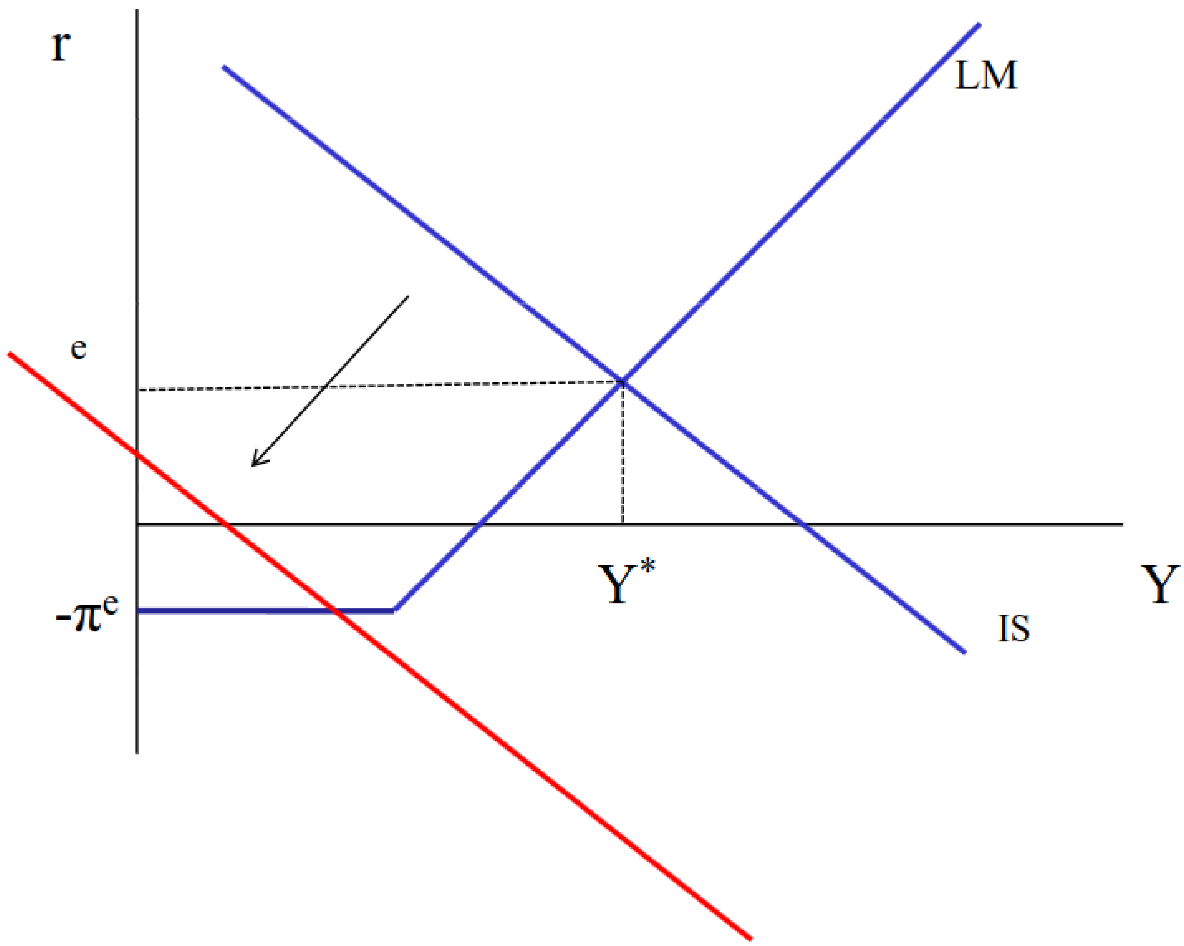


Fiscal policy = control of G.



Output is unchanged and G has crowded out C and I (through higher r)[32]

Liquidity trap: r cannon be reduced lower than $-\pi^e$.



Phillips curve. What happens in the long run?

$$\frac{w_t}{w_{t-1}} = w\left(\frac{p_t}{p_{t-1}}, U_n\right)$$

Here U_n is unemployment rate and w is increasing in $\dfrac{p_t}{p_{t-1}}$ and decreasing in U_n.

Price is an increasing function $p_t = p\left(Y - Y^*, \dfrac{wL}{Y}, p_{t-1}\right)$. This gives the connection between unemployment and inflation.

Phillips empirical relationship:

$$\frac{dw}{dt} = \frac{a}{U_n} - b$$

Since $\dot{p} \propto \dot{w}$ (another empirical fact), we have

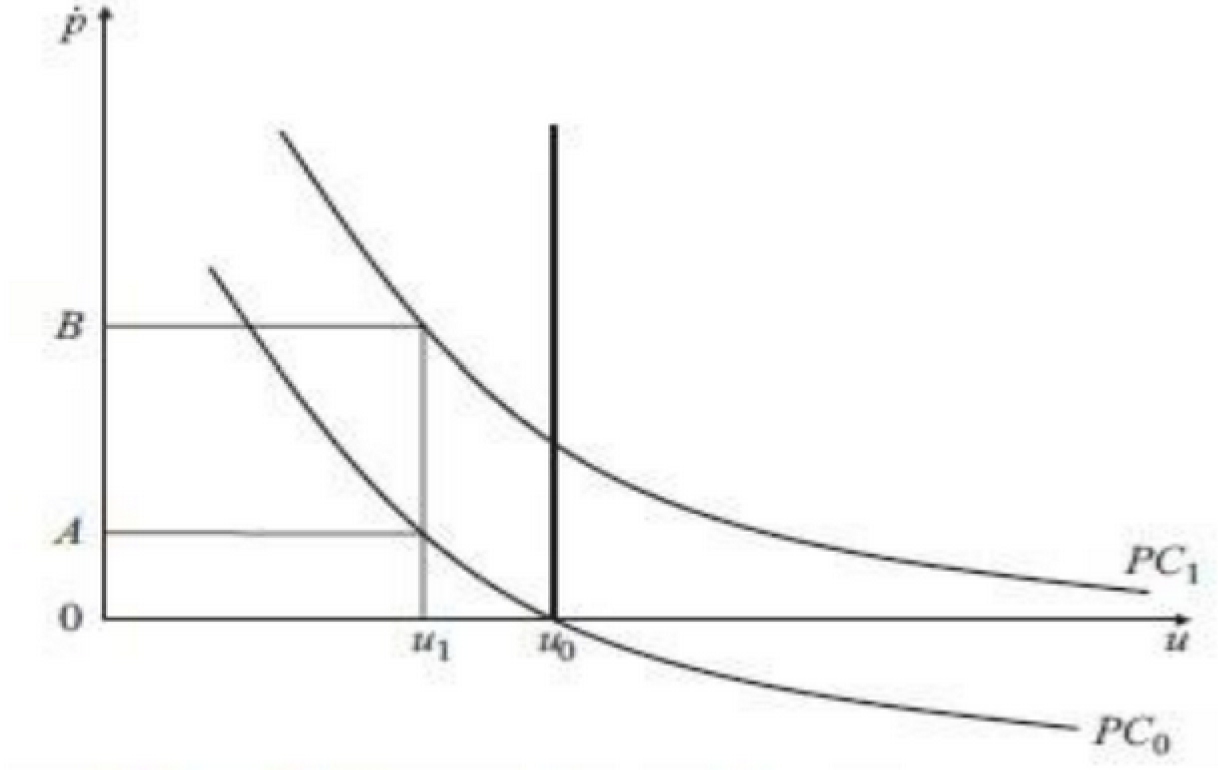
$$\frac{dp}{dt} = \frac{a}{U_n} - b$$

This means that inflation is an inverse function of unemployment.

Agent's expectations

Milton Friedman: firms anticipate inflation in real time, workers anticipate it with time lag (money illusion).

1. Inflation rises from O to A, firms hire more people, workers do not correct the labor supply. Unemployment falls.
2. Workers anticipate inflation OA and ask for wage increases –> inflation rises from A to B.
3. Firms react to AB inflation, wages and inflation fall, unemployment rate returns to the initial level along the new curve with higher inflation…



Quantitative money equation (Irving Fischer)

$$M_s V = pY$$

where V is money "velocity".

IS-LM. Linear version

IS curve

$$C = A + bY,\ b \in (0,1)$$
$$I = E - er, r \in (0,1)$$
$$NX = X - M, \quad M = F + fY, \quad f \in (0,1)$$
$$G, X \text{ are exogenous.}$$

Be the equation (LS) we obtain

$$Y = \frac{A+E+G+X-F}{1-b+f} - \frac{e}{1-b+f} r \tag{LS}$$

Multiplier $\dfrac{1}{1-b+f}$ is weaker for open economies ($f > 0$).

LM curve

$$\frac{M_s}{P} = L_d(Y, r + \pi^e) = \frac{L_{d1}}{P} + \frac{L_{d2}}{P}.$$

Here

- L_{d1} is transactional money demand: $\frac{L_{d1}}{P} = \alpha Y$. Demand for money to buy consumer and investment goods.
- L_{d2} is demand for speculative money = - demand for long-term bonds: higher rates –> higher demand for bonds -> lower demand for speculative money. $\frac{L_{d2}}{P} = -\beta r$.

So, money market is

$$\frac{M_S}{P} = \alpha Y - \beta r$$

and LM curve

$$Y = \frac{M_s}{P\alpha} + \frac{\beta}{\alpha} r \tag{LM}$$

IS-LM equilibrium

$$Y = \frac{1}{1 - b + f + r\alpha/\beta} \left(A + E + G + X - F + \frac{e}{\beta} \frac{M_s}{P} \right)$$

Debts and financial crisis

We add new debts to the Keynesian aggregate demand

$$Y = C + I + G + NX + D$$

However, it does not explain the decrease of the aggregate demand due to the lag: credit growth is decreasing after the decrease of the aggregate demand.

If we start with $Y = C + I$ and assume that investment is fully financed by borrowing $I = \Delta D$, we obtain

$$\Delta Y = \Delta C + \Delta \Delta D$$

Here the change of GDP is explained by the second derivative of debt ("credit impulse"). This allows to construct cool models explaining crisis, business cycles etc.

Debt macro-model (Biggs–Mayer–Pick)

GDP is separated into durable $Y_{d,t} = I_t$ and non-durable goods $Y_{c,t} = C_t$.

$$C_{c,t} = AK_t$$

The capital good consist of depreciated at rate δ capital at the previous step and the investments I_t:

$$K_t = (1-\delta)K_{t-1} + I_t$$

Profit optimization (intuition: interest rate is equal to productivity – depreciation) –> interest rate on loans $r = A - \delta$ and the firm's income is $(r+\delta)K_t$. The first part paid as the interest the second allows to repay δK_t of debt D_t which is equal to K_t as all investments are financed by debt:

$$D_t = (1-\delta)D_{t-1} + I_t$$
$$I_t = \Delta D_t + \delta D_{t-1}$$

The GDP can be rewritten

$$Y = C_t + I_t = (r+\delta)K_t + \Delta D_t + \delta D_{t-1} = (1-\delta)\Delta D_t + (2\delta + r)D_t.$$

Hence, GDP is a function of debt and its growth. For the reasonable values of δ and r coefficient in front of ΔD_t is more significant.

The growth rate of GDP

$$y_t = \frac{Y_t - Y_{t-1}}{Y_{t-1}} = (2\delta + r)\frac{\Delta D_t}{Y_{t-1}} + (1-\delta)\frac{\Delta D_t - \Delta D_{t-1}}{Y_{t-1}}$$

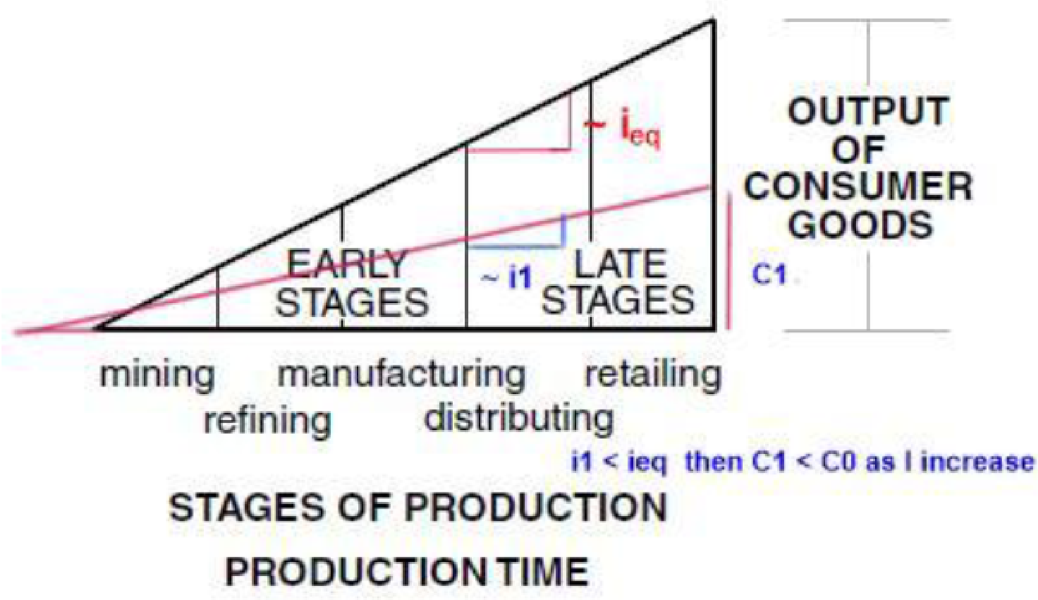
The second term corresponds to the "credit impulse".

Diagrammatic modeling

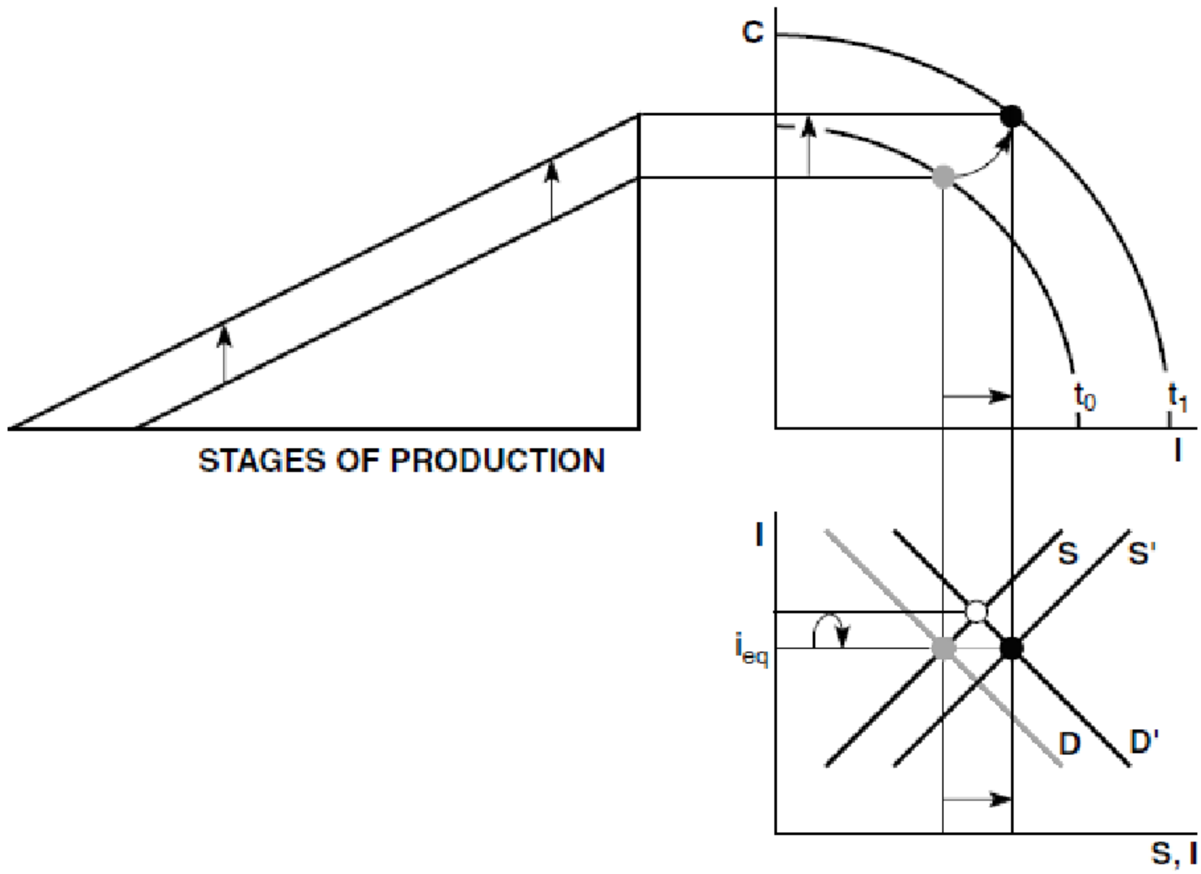
Hayekian triangle

C is an increasing function of i as $I(i)$ is decreasing.

Time of production is decreasing function of i.



Sustainable growth

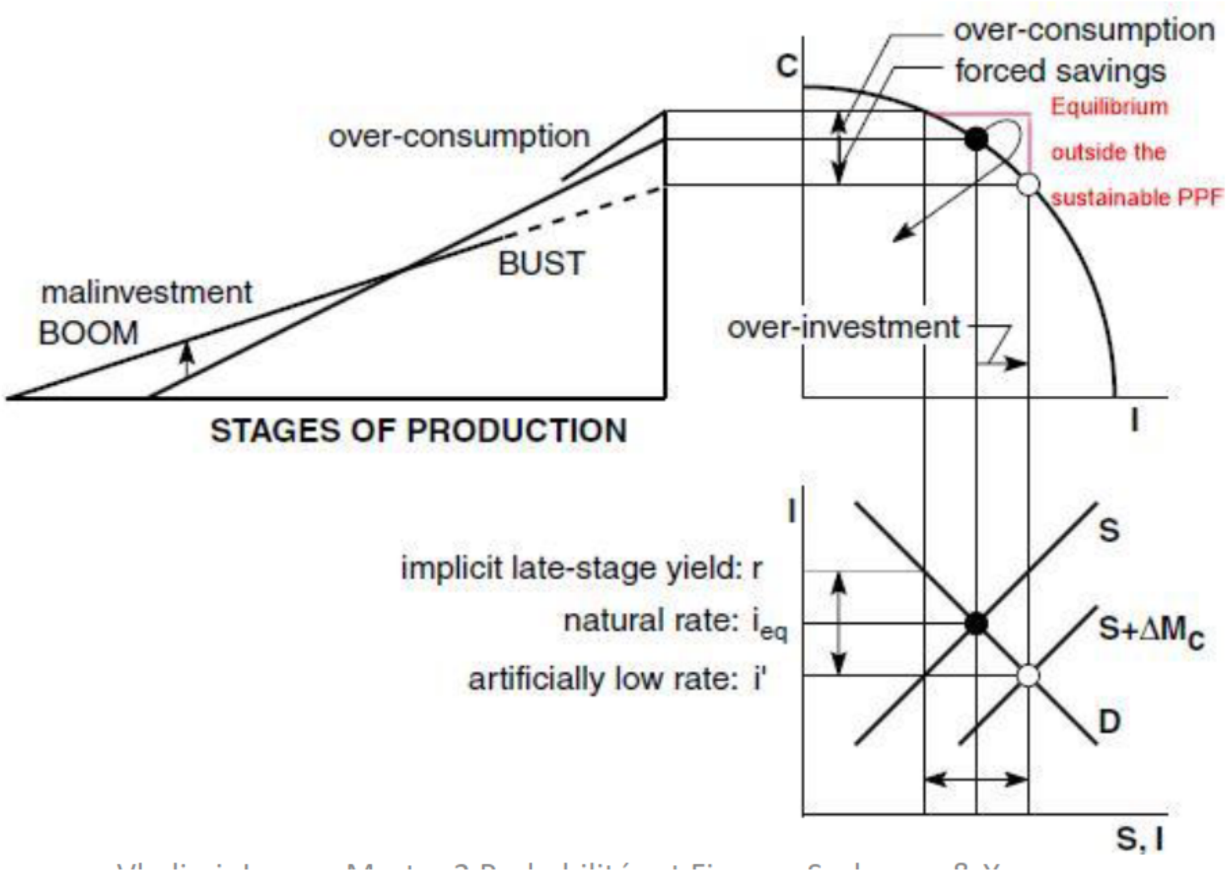


1. Rising productivity –> rising demand –> rising i

2. Rise of i and revenues –> rising of savings S (supply)

3. C and I increase –> higher and more stable production possibilities frontier.

Unsustainable growth



1. Rising M_s –> rising savings –> rising I
2. C is not decreased (as ΔI is financed by ΔM). False expectation of Boon –> overconsumption $C + \Delta C$.
3. The equilibrium is outside the sustainable PPF –> I and C should return to the initial equilibrium, but it could take a lot of time. System won't come back and could overshoot –> secondary deflation.