Theories of development

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Lewis model of Structural Transformation (1954)

- **1979 Nobel prize winner**

- He proposed the idea of development as a transformation of an economy from agricultural to industrial one.

Development: Structural transformation

- In developing countries majority of the people (40 to 70%) depend on agriculture for their livelihood, but agriculture contributes a disproportionately small share to GDP (20 to 30%)
- In developed countries majority of the population depends on industry or services (share of agriculture in US and UK: about 1.2%).
- Share of agriculture in GDP in US or UK is also about 1.5%
- Urban and rural population in Kyrgyztstan is 2/3 and 1/3 respectively, while share of agriculture in GDP is roughly 14.5~15.0%

Development: Structural transformation

- That is the percentage of people dependent on agriculture should not be too different to the percentage of GDP coming from agriculture.
- If too many people depend on agriculture then the agricultural sector will be stressed.

- So development must involve some sort of structural transformation – **moving people out of agriculture to industry**

Lewis model of two sectors – agriculture and industry

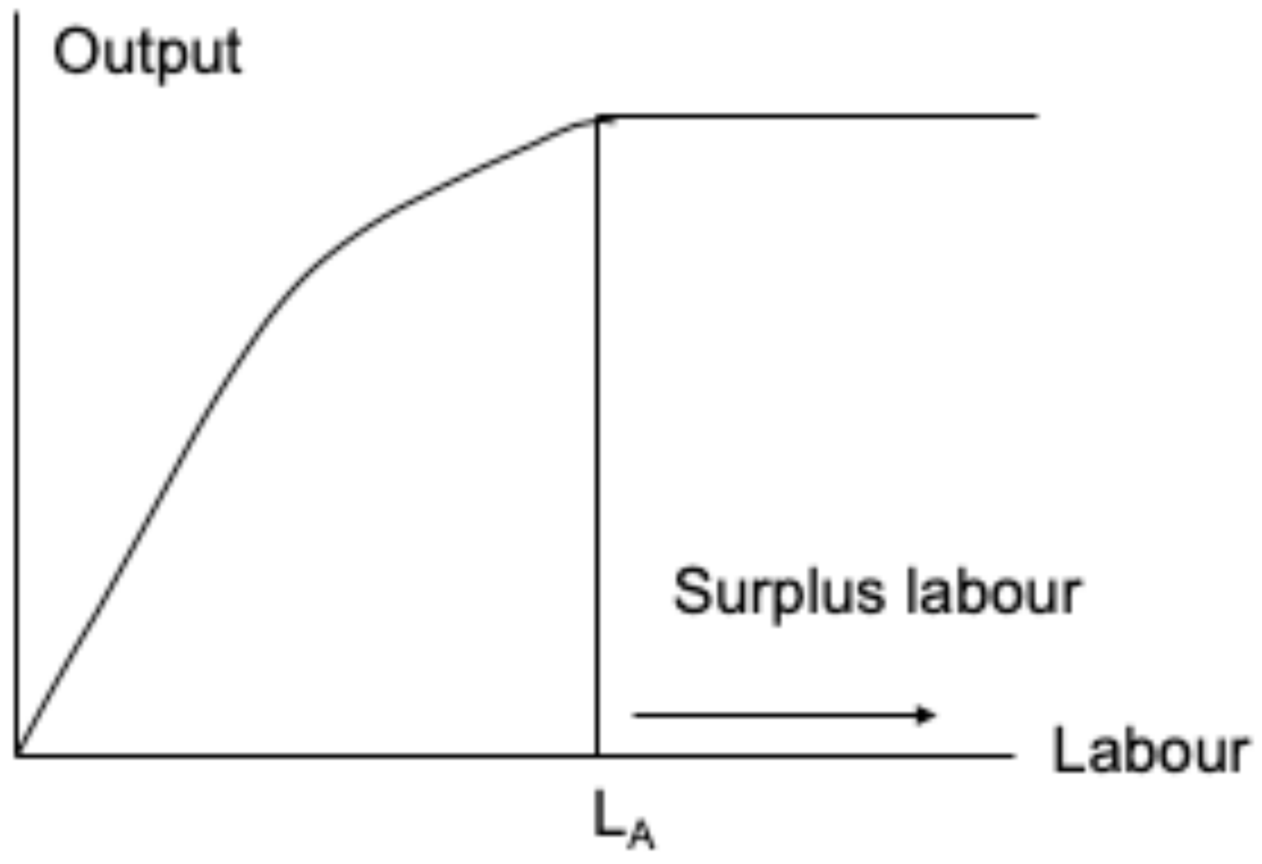
- **Agriculture**

  - **Backward sector**
  - Lots of surplus labour (meaning MP of labour =0)
  - Farming is household based. Each member of the household receive a wage = Average product of labour (by sharing outputs among themselves)

  - Labour is not valued at the market rate.

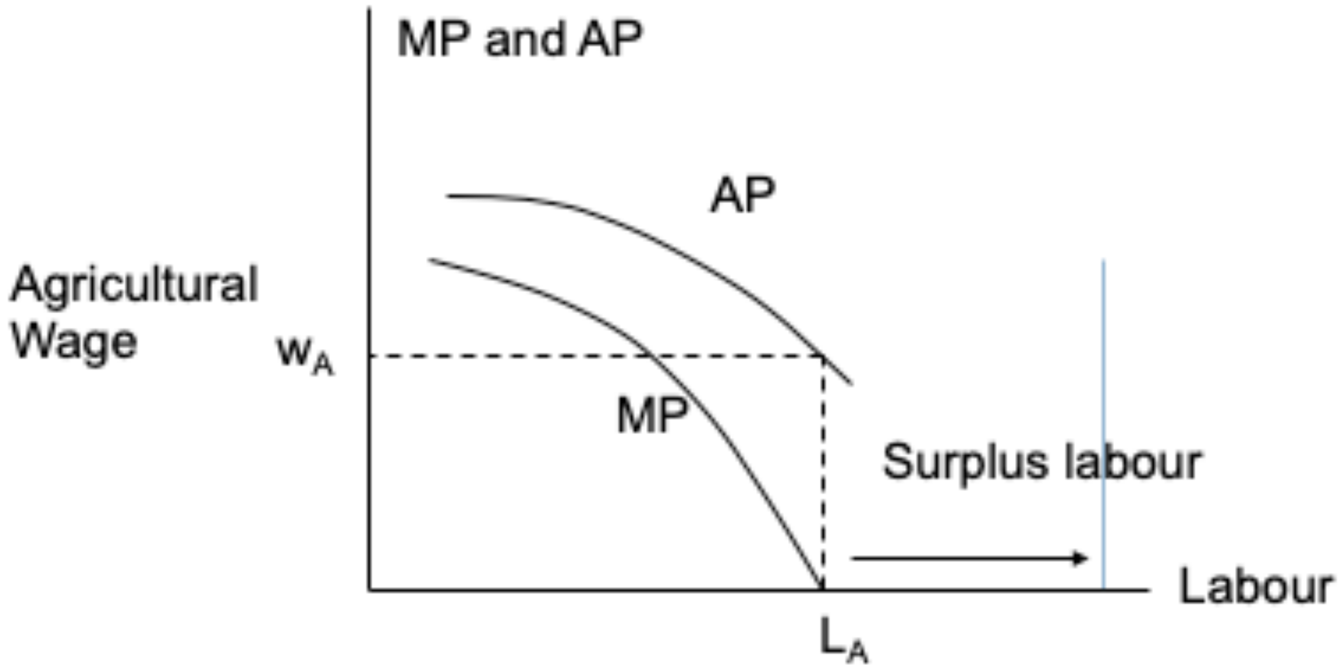
Graph of agriculture

- Agricultural production function



Graph of agriculture

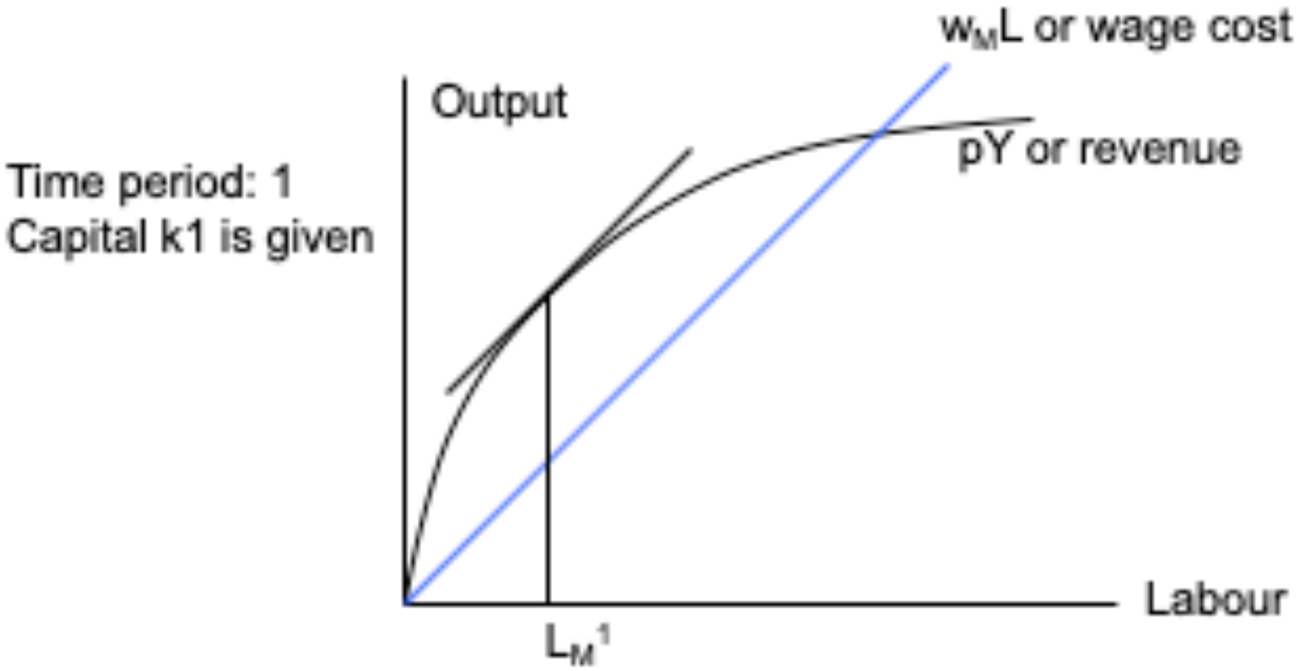
- Agricultural MP and AP



Industry

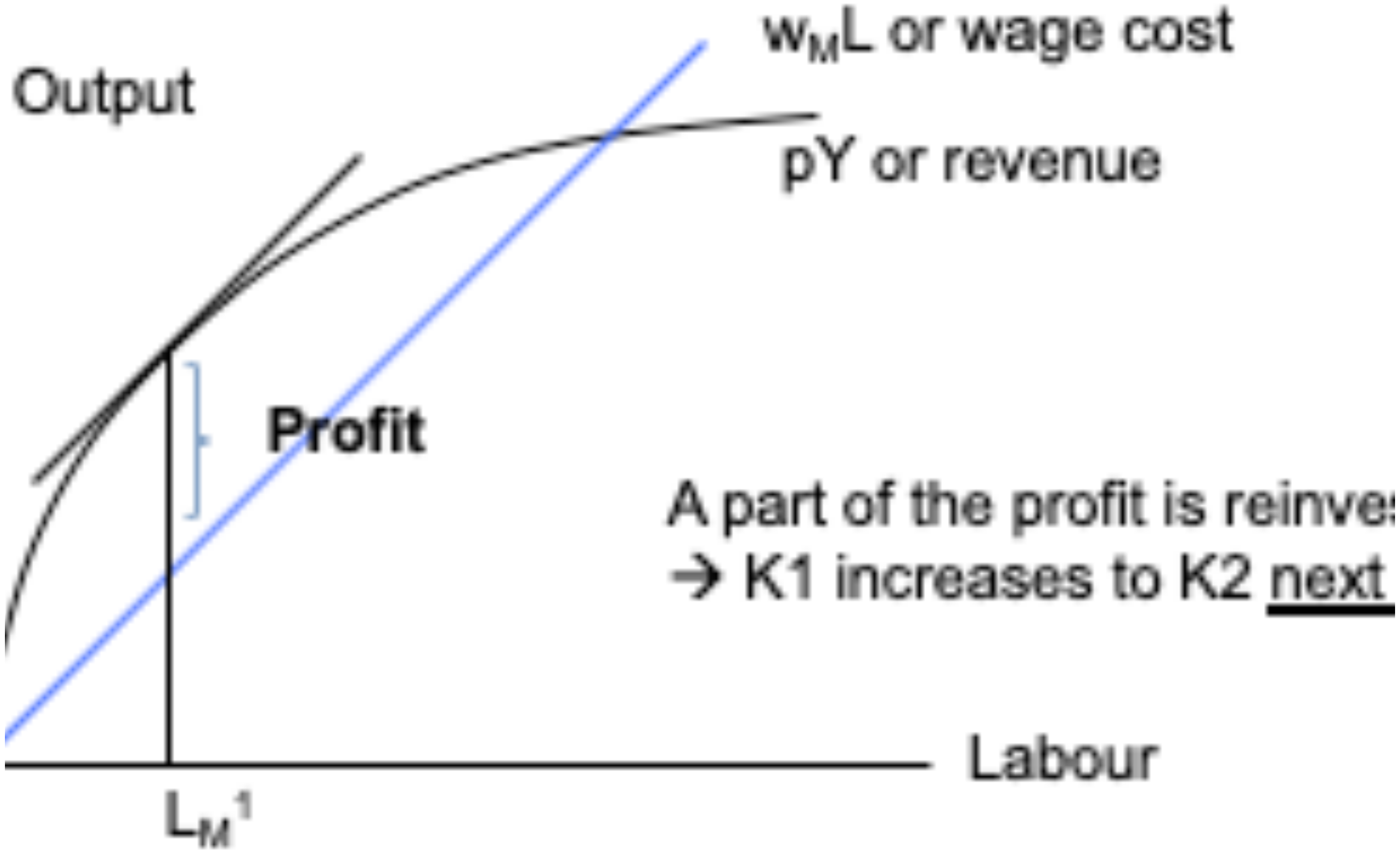
- Modern sector: Profit maximizing firm
- Workers are hired by setting
- VMP of Labour =Wage
- **Constant wage rate (over time) (why?)**
- **Profits are reinvested over time (why?)**
- Labour-scarce sector (but depends on labour migrating from agriculture)

Graph of industry



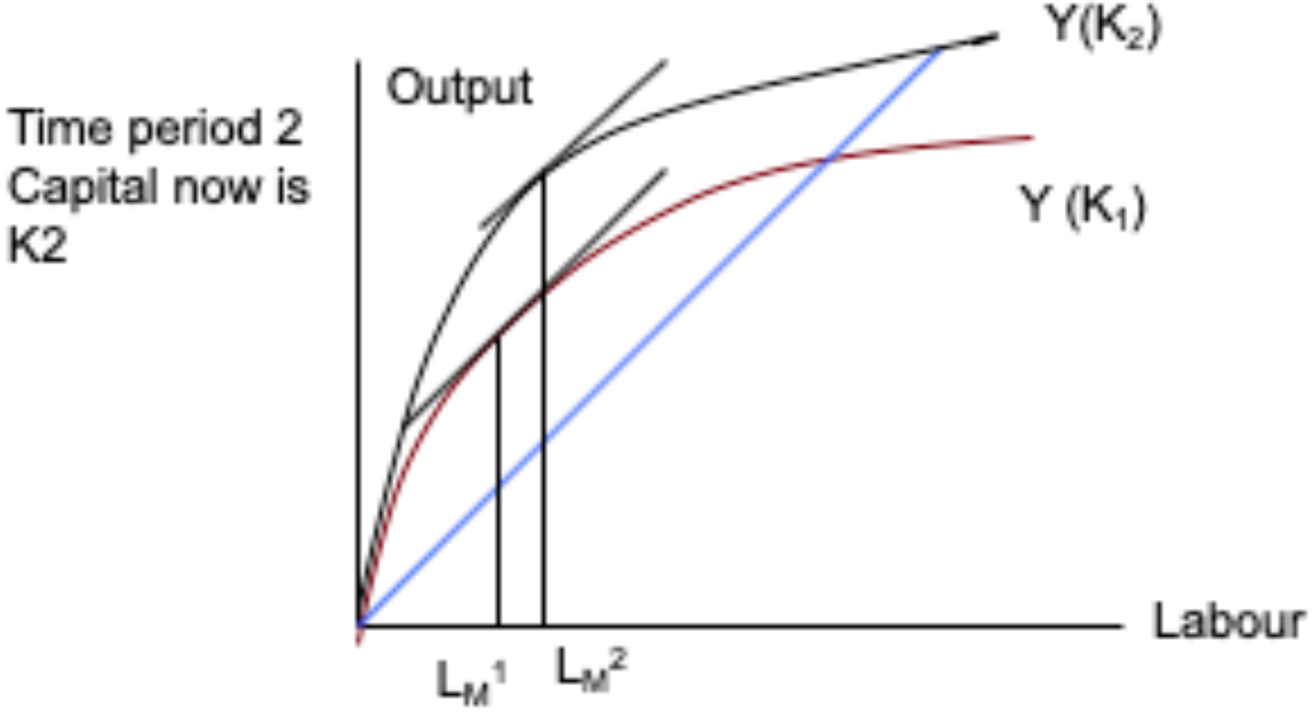
- Industrial production function

Graph of industry



- Industrial production function

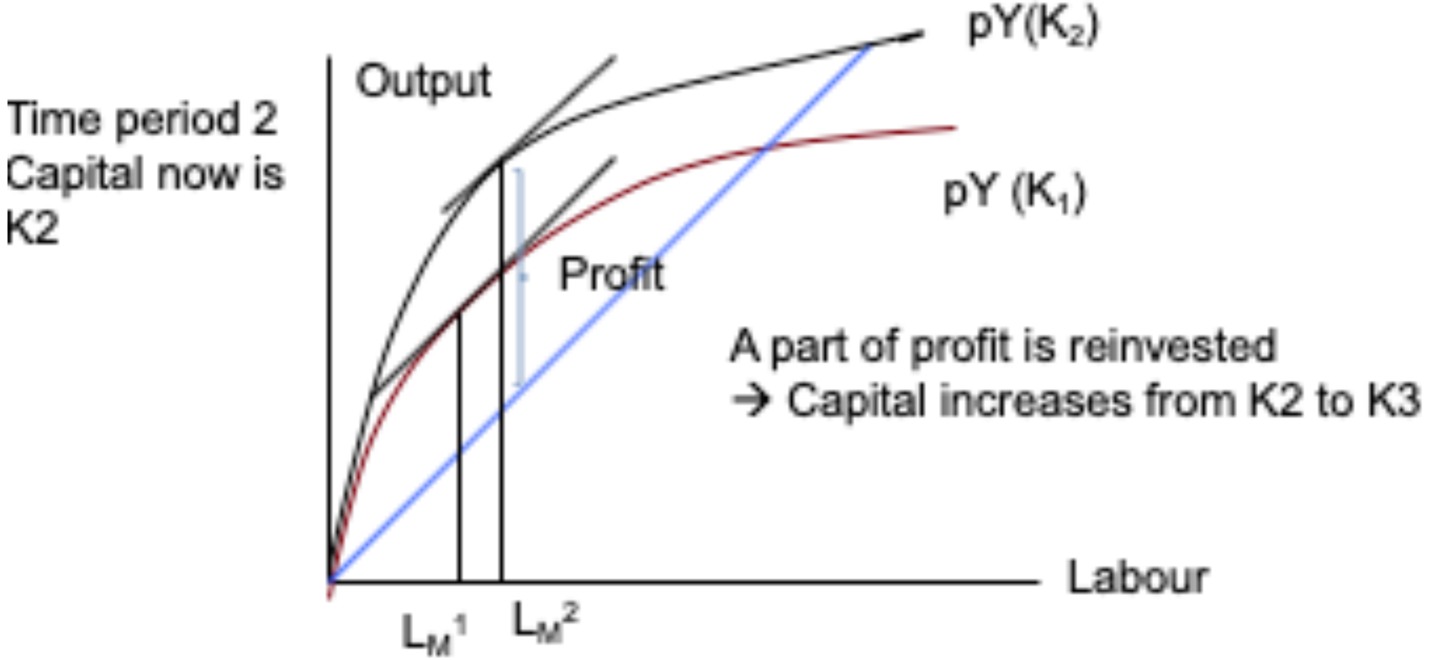
Graph of industry



- Industrial production function

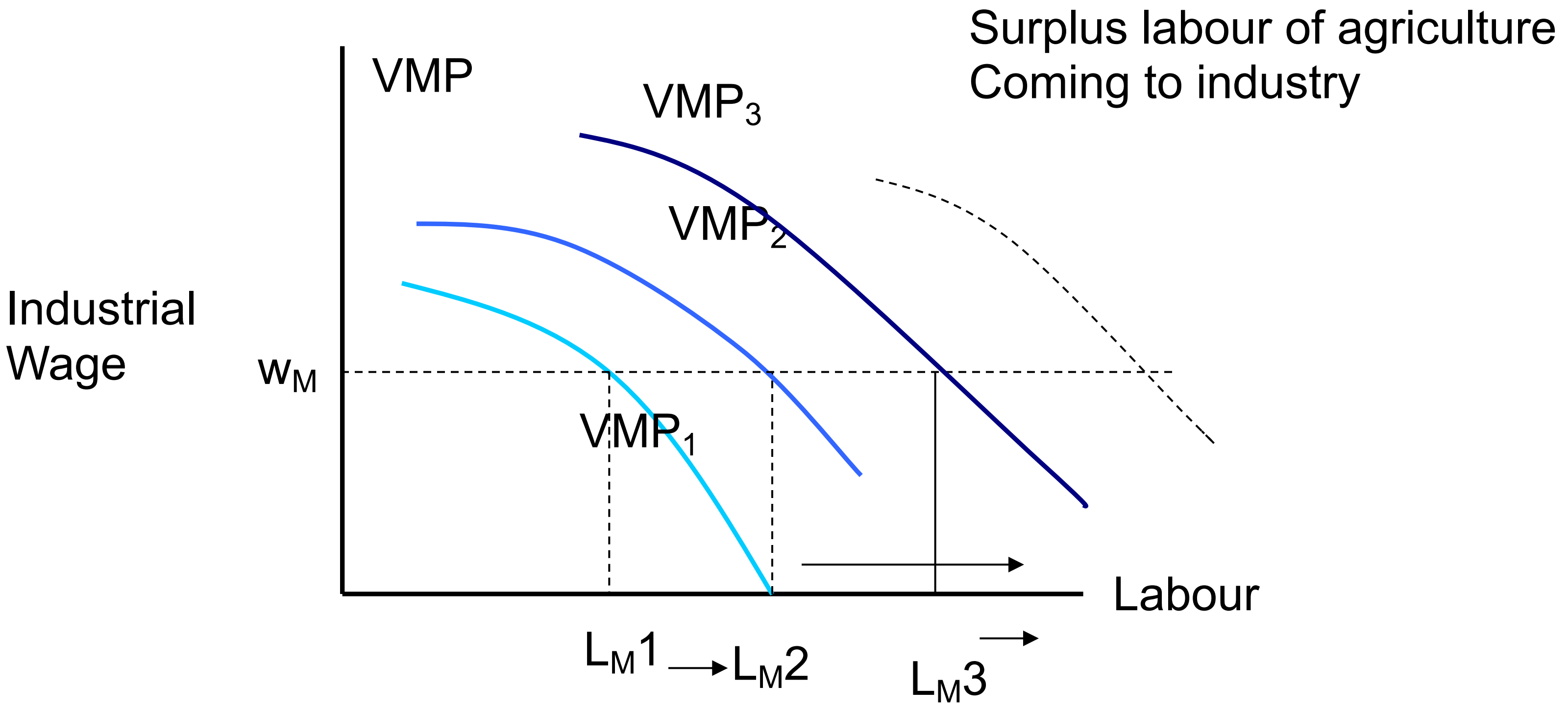
Graph of industry

Industrial production function



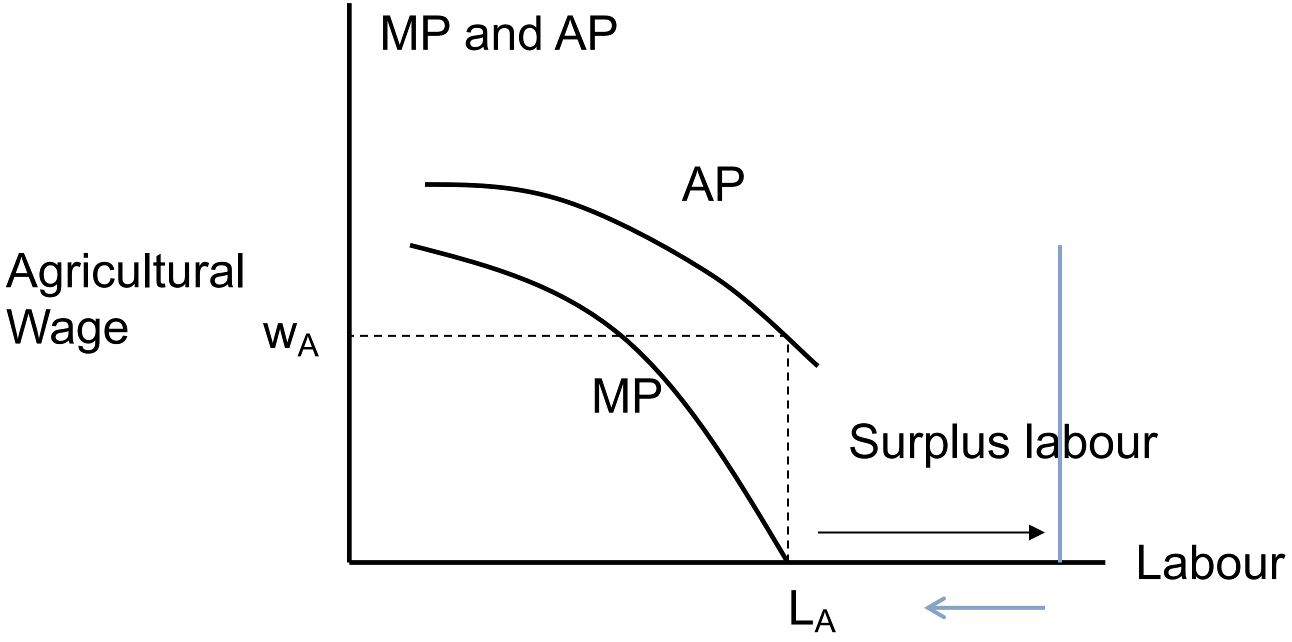
Rapid expansion of employment in industry via constant shift of VMP

- Industrial MP



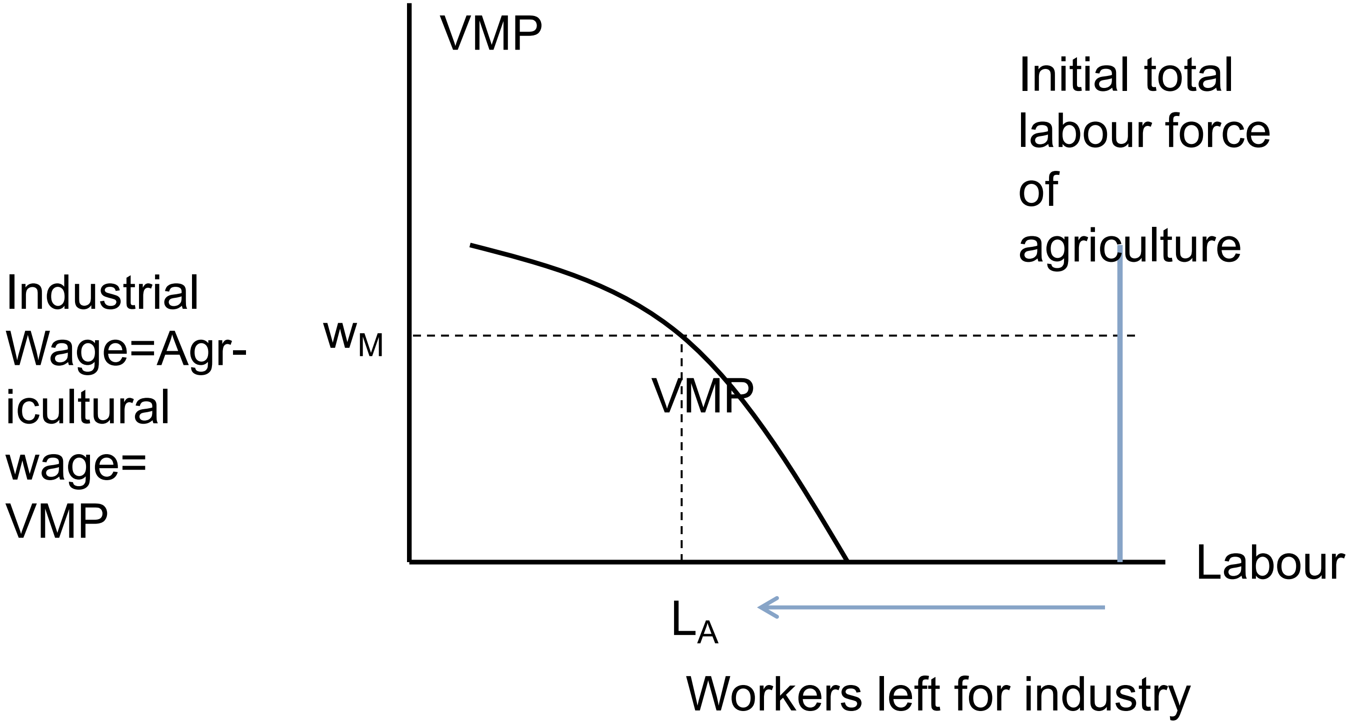
Withdrawal of surplus workers from agriculture

- Initially agricultural production is unaffected as surplus labour leaves for industry



Long run equilibrium: workers stop moving out of agriculture

- Initially agricultural production is unaffected as surplus labour leaves for industry



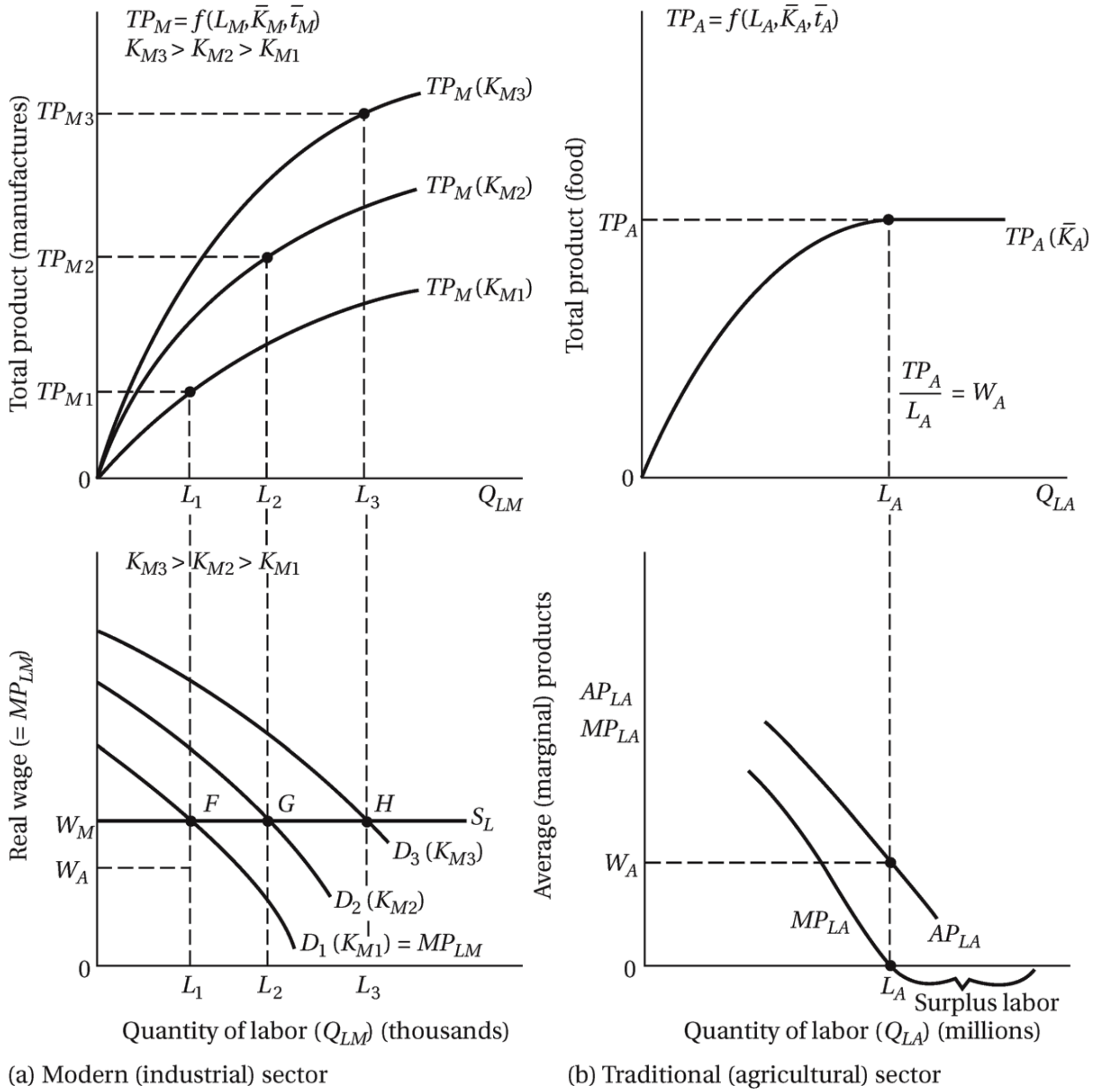
Source of industrial growth

- Why do the industrial MP and production function shift out?
    - Because of reinvestment of profit and capital accumulation and continuous attraction of labour

- Industrial wage > agricultural wage

- The process will continue until the surplus labour of agriculture is exhausted and two wages become equal

Figure 3.1 The Lewis Model of Modern-Sector Growth in a Two-Sector Surplus-Labor Economy



Short run industrial growth prediction

- Short run: The model works well, surplus labour is moved from agriculture to industry
- No loss in agricultural production
- **Profit is reinvested to increase capital**
- As industry expands, and agricultural output does not fall, GDP increases
- Reinvestment of profit and increase in capital sustains industrial production
- Structural transformation takes place

Long run: Industrial expansion stops

- Industrial expansion stops with the exhaustion of the surplus labour in agriculture
- With agriculture being modernised rural labour will be valued at the market wage
- Wage of the agricultural sector will become equal to the wage of the industrial sector
- Industrial growth may end sooner if the industrial wage rises.
- To get further industrial growth: need immigration, wage cut, or labour saving technology

Criticisms- Lewis Model

- 1. Rate of labor transfer and employment creation **may not be proportional** to rate of modern-sector capital accumulation.
- 2. What if the modern sector employs labour saving technology? In that case, the labour absorption argument fails.
- **3.** How realistic:
  - **Surplus labor** in rural areas and full employment in the urban sector? Is profit always reinvested?
- 4. Institutional factors missing (role of the State)!

Criticisms of the Lewis model

- 5. Fixed industrial wage: Does not match with the reality of trade unions

- 6. The vision of agriculture as a backward sector as propagated by the Lewis model encouraged the policy makers in developing countries to neglect or abandon the agricultural sector, rather than invest in it, which we know now had severe consequences.

Criticisms of the Lewis model

- 7. Favouring industry ahead of agriculture by policy makers also created unchecked migration to cities and created an informal industrial sector, contrary to Lewis' vision.

- 8. Role of service sector is completely ignored

Lewis model at work

- Policy makers around the world were highly influenced by the Lewis model →
- Neglect of agriculture (restriction on agricultural trade, forced low return in agriculture. Example: ban of rice and agricultural essential commodities export in India)

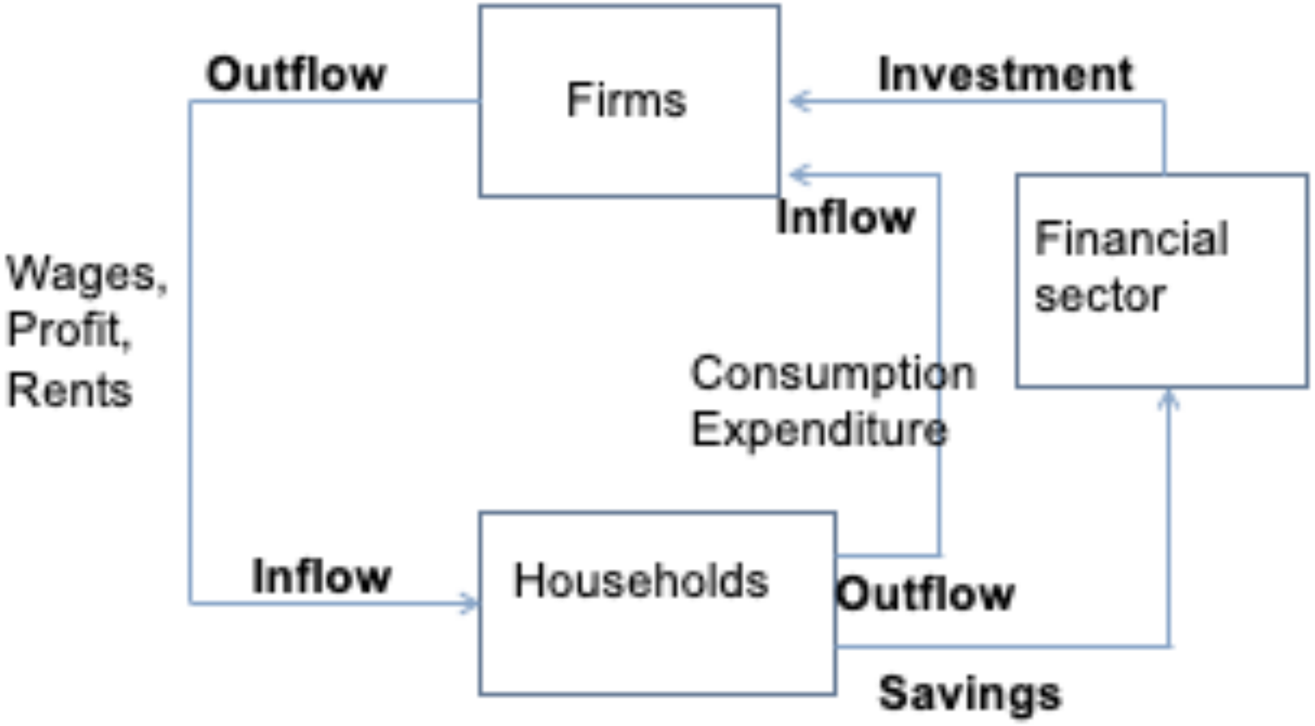
- **Urban bias of development !!**

Growth theories

Growth Models

- Exclusive focus on GDP growth
- A theory of growth requires explaining a self-sustaining process of income increases:
  - Capital needed for output (GDP)
  - Need saving from households and translate it into investment
  - Investment augments capital → GDP grows

Growth: Sustained increase in the scale and intensity of the circular flow of income



Four growth models

- The Harrod-Domar growth model (1939, 1946)
- Modified Harrod-Domar model
- The Solow model (1956)
- Endogenous growth models (1986, 1988 onward)

Two key relations in any growth model

- 1. An equilibrium condition at every time period
- 2. A dynamic link equation linking the two time periods (usually, investment)

Harrod-Domar growth model

- Three important variables (all given exogenously, i.e. do not depend on GDP):
  - *s*: the constant saving rate
  - *v*: the incremental capital-output ratio (or the proportion of extra output or GDP going to investment)
  - *n*= Population (=labour force) growth rate

Harrod-Domar growth model

- Savings equation: $S_t = sY_t$
- (Y is aggregate GDP, S is aggregate saving, I stands for investment
- $I_t = K_{t+1} - K_t = \frac{K_{t+1}}{Y_{t+1}} Y_{t+1} - \frac{K_t}{Y_t} Y_t$
- Assume $\frac{K_t}{Y_t} = v$ constant at all t.
- So $I_t = v(Y_{t+1} - Y_t)$

Express the equilibrium in per capita terms

- Per capita Savings equation: $S_t / L_t = sY_t / L_t$
- Write in notation: $S_t / L_t = sy_t$

- Divide the investment equation by L_t.

- $I_t / Lt = v(Y_{t+1}/Lt - Y_t/Lt)$
- $I_t / Lt = v[(Y_{t+1}/Lt_{+1})(L_{t+1}/L_t) - Y_t/Lt)]$

H-D growth model

- If the population growth rate is constant (n),

  then $L_{t+1} = L_t(1+n)$ for all t.

So the per capita investment equation becomes

$$I_t/Lt = v[(Y_{t+1}/Lt_{+1})(Lt_{+1}/Lt) - Y_t/Lt)]$$

$$= vy_{t+1}(1+n) - vy_t$$

H-D growth model

- Now set per capita S_t equal to I_t

$$sy_t = vy_{t+1}(1+n) - vy_t$$

Divide both sides by y_t.

$$s = v(y_{t+1}/y_t)(1+n) - v$$

If the per capita output growth rate is constant, say g, then $y_{t+1} = (1+g)\, y_t$

Hence, $\quad s = v(1+g)(1+n) - v$

Or, $\quad g(1+n) = (s/v - n)$

H-D growth model

- $g(1+n) = (s/v - n)$

- Where
  - g: growth rate in per capita GDP/output $\Delta y/y$
  - s/v: growth rate of output/GDP (not per capita)
  - n: population growth rate

- Steady state growth, where Y, K and L grow at the same rate:
  - Per capita *Y* will conversge to a constant number with no further growth.
  - That means g=0, which requires $s/v = n$.
  - But this can happen only by accident, because all three variables are given exogenously

Harrod-Domar model: Self-sustaining growth, or Knife-edge problem?

- **Knife-edge!**
  - If $s/v > n$, per capita income grows **forever (Takeoff to growth)** because $\Delta y/y > 0$ [*runaway growth !!*]
  - If $s/v = n$, per capita income stays constant **forever (stagnancy**), because $\Delta y/y = 0$
  - If $s/v < n$, per capita income falls **forever** (economic regression), be**cause** $\Delta y/y < 0$

Evidence of HD model in practice

- Harrod-Domar growth model can be seen as a model of growth engineering: a target level of growth can be achieved by 'controlling' investment and production flows.

- The communist USSR (now dissolved) following the Bolshevik revolution of 1917 provide the first controlled experiment of growth engineering (much before Harrod and Domar).

- More recently, China's one child policy can be seen as a 'growth engineering' policy (reduction of n in the equation '$s/v - n$').

Limitations of the HD growth model

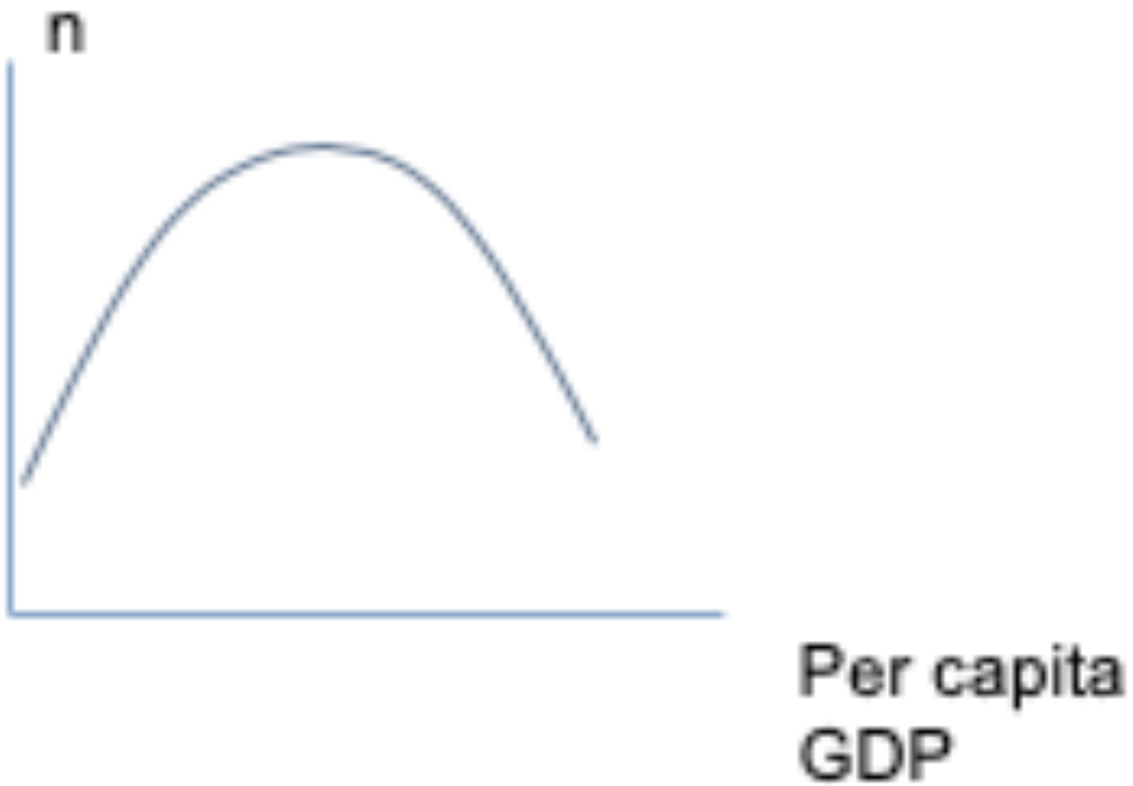
- Key variables of the growth equation are exogenously given
  - Growth is a disequilibrium phenomenon (theoretically not very satisfactory)
  - The knife-edge prediction is hard to support empirically
- How to avoid the knife-edge problem?
  - Modify the HD model
  - Solow model

- Modified Harrod-Domar model

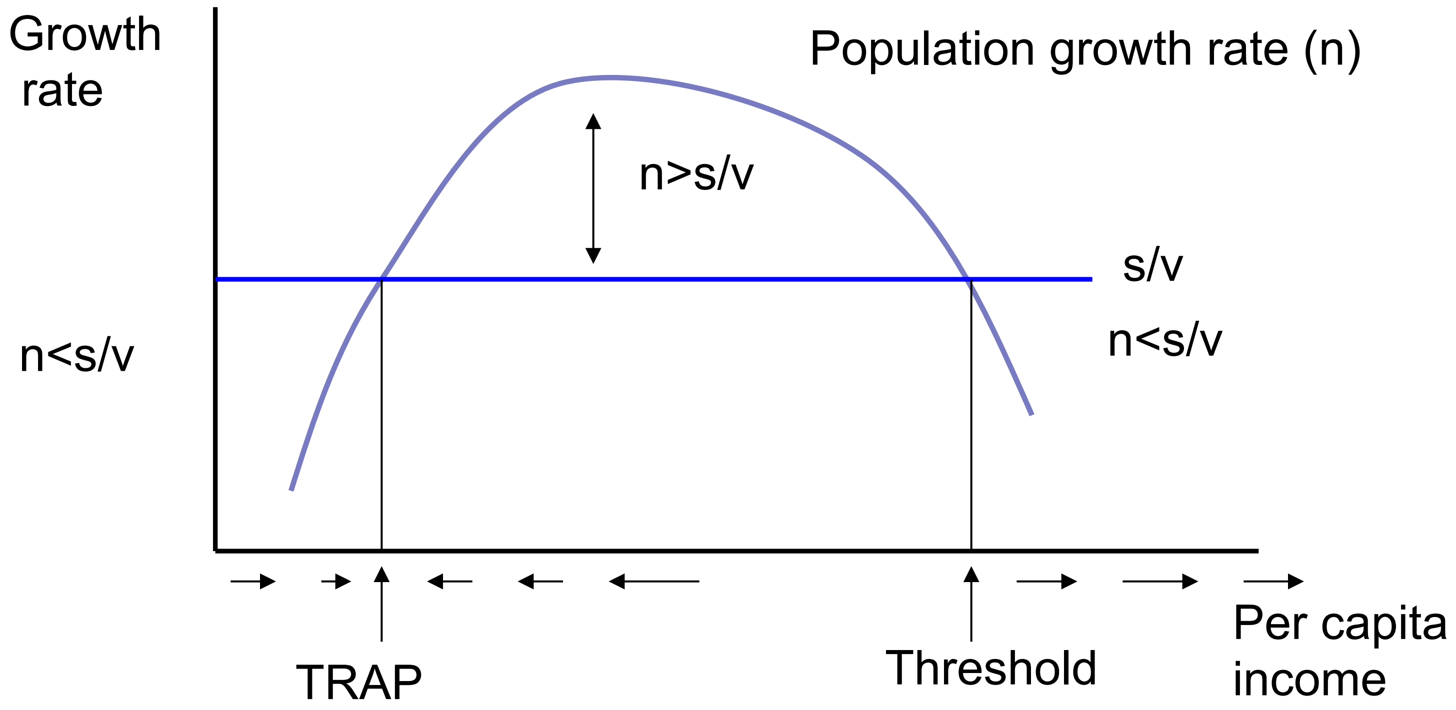
Modify the Harrod-Domar model

(Endogenous population growth rate)

- In the Harrod-Domar model assume that population growth rate (*n*) is no longer constant.
- Assume that when an economy becomes richer, *n* first rises and then after a point it starts declining. *n* will vary with *t*.
- Equilibrium condition : $\Delta y_t / y_t = s/v - n_t = 0$



Modified H-D model: the trap and threshold model



Either stagnate or grow forever

- Until the threshold level of income is exceeded, the economy will not grow steadily; in fact it will fall back into a low income trap.

- Once the threshold is crossed, the economy will keep expanding forever (the positive knife-edge phenomenon)

- The knife-edge problem is reduced here (but does not disappear).

- The foundation is demography-based, and is somewhat ad hoc.

- Solow Model

- (or rather Solow-Swan model)

Key assumptions of the Solow model

- The capital-output ratio *v* is not constant. It is rather dependent on the per capita income *Y*/*L* (= *y*)
  - Recall: In Harrod-Domar this was constant causing a knife-edge problem

- So *v* will vary with time and is to be denoted as v_t.
-
- Savings rate is constant: *s*

- Population to grow at a constant rate: *n*.
- Constant depreciation rate of capital: δ

Key assumptions of the Solow model

- Decreasing returns to scale (DRS) in the production of per capita GDP. That is, if per capita capital (*K/L* or *k*) rises by 100%, per capita GDP (*y*) will rise by less than 100%.

- Write $Y/L = f(K/L)$ (in per capita terms)
- or $y = f(k)$, $f'(k)>0$, $f''(k) <0$ (DRS in terms of *k*)

- As long as capital (per capita) grows, per capita GDP will also grow, as capital (per capita) is the only input.

Neo-classical growth model: The Solow model (1956)

- Neo-classical: meaning equilibrium-based and relying on market mechanisms. The Solow model is the most well known model of this genre.
- Basic Assumptions:
  - Aggregate macro economy is described by a one-sector economy or one aggregate good which is produced by a production function: $F(K, L)$
  - Constant saving rate (s)

Solow model

- The capital-output ratio v should not be constant.

- Allow population to grow at a constant rate n.

- Allow (for the economy) constant returns to scale in (K,L).
- Production function:

$$Y = F(K,L)$$

- Write $Y/L = F(K/L, 1)$ (in per capita terms)

- Or

  → $y = f(k)$, $f'(k)>0$, $f''(k) <0$ (DRS in terms of k)
- (See Example in next slide)

Example of a CRS function

Suppose production is given by a CRS Cobb-Douglas production function:

$Y = A K^a L^{1-a}$, $0<a<1$.

Divide both sides by L, and get

$(Y/L) = A K^a L^{1-a}/\mathrm{L} = A K^a L^{-a}, = Y = A (K/L)^a$,

Or $\mathrm{y} = A k^a$,

Since a <1, this function gives decreasing returns to scale in '*k*.'

Solow model

- **Key equilibrium condition**
- $\boldsymbol{S_t = I_t}$ or in ln per capita terms we can write $\boldsymbol{(S/L)_t = (I/L)_t}$

- Equilibrium every time period
- And time t saving is carried forward to t+1 and converted into investment which leads to greater capital stock in t+1

Now expand each term of the equilibrium conditon: Per capita saving → $(S/L)_t = s(Y/L)_t = \boldsymbol{sy_t}$ (1)

Solow model: Investment

- Now consider per capita investment (I_t/L_t)

Investment by definition is: $I_t = K_{t+1} - K_t(1-\delta)$

Rewrite it in per capita term as:

$$(I/L)_t = (K_{t+1} / L_t) - (K_t/L_t)(1-\delta)$$

Or, $$(I/L)_t = (K_{t+1} / L_t) - k_t(1-\delta)$$

Now pay attention to $\boldsymbol{(K_{t+1} / L_t)}$. This can be rewritten as

$$(K_{t+1}/L)_t = \boldsymbol{(K_{t+1} / L_{t+1})(L_{t+1} / L_t)}$$
$$= \boldsymbol{k_{t+1} (L_{t+1} / L_t)}$$

Working of the Solow model

- Assumption: labour L grows at a constant growth rate n, → then we get $L_{t+1} = L_t(1+n)$, or
  - $\boldsymbol{(L_{t+1} / L_t) = 1+n}$ **(2)**

- Now return to the equilibrium condition $\boldsymbol{(S/L)_t = (I/L)_t}$

- Substitute the per capita savings expression (1) and the labour growth equation (2) in the equilibrium condition:
  - $sy_t = [K_{t+1}/L_{t+1}](1+n) - k_t(1-\delta)$
  - $sf(k_t) = k_{t+1}(1+n) - k_t(1-\delta)$
  - $k_{t+1}-k_t = sf(k_t) - n\,k_{t+1} - \delta\,k_t$

- Solow growth equation:

$$\boldsymbol{\Delta k_t = sf(k_t) - nk_{t+1} - \delta\,k_t}$$

Solow growth equation

- $\Delta k_t = sf(k_t) - nk_{t+1} - \delta k_t$

- Steady state growth: Capital, Labour and GDP must grow at the same rate→ $k_{t+1}=k_t$ for all t

- Growth in per capita capital (k) and output (y) will be zero in equilibrium → $\Delta k = 0$

- Steady state: Time subscripts do not matter.

- → $\Delta k = sf(k) - k(n+\delta)$
- → $\Delta k/k = s[f(k)/k] - (n+\delta) = \boldsymbol{(s/v^*) - (n+\delta)}$

Solow model

- Per capita capital, and so per capita GDP, will grow if
- $sf(k_t) > nk_{t+1} + \delta k_t$

- Per capita capital and per capita GDP will contract if

$$sf(k_t) < nk_{t+1} + \delta k_t$$

- Steady state equilibrium when everything grows at the same rate (time subscripts don't matter here)

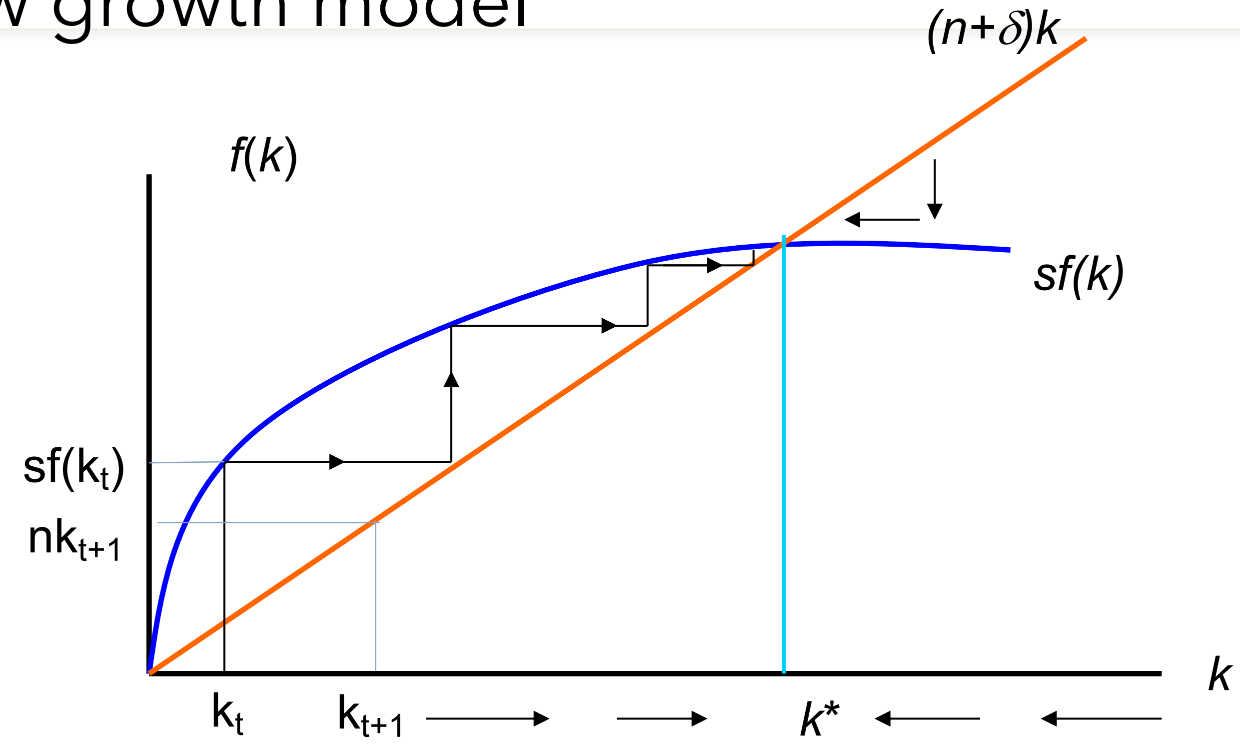
$$\boldsymbol{sf(k^*) = (n+\delta)k^*} \quad \text{or} \quad \left[s/v^* = n, \text{ as } v^* = k^*/f(k^*)\right]$$

Per capita capital and GDP will stop growing in the steady state equilibrium.

That is, GDP and population will grow at the same rate.

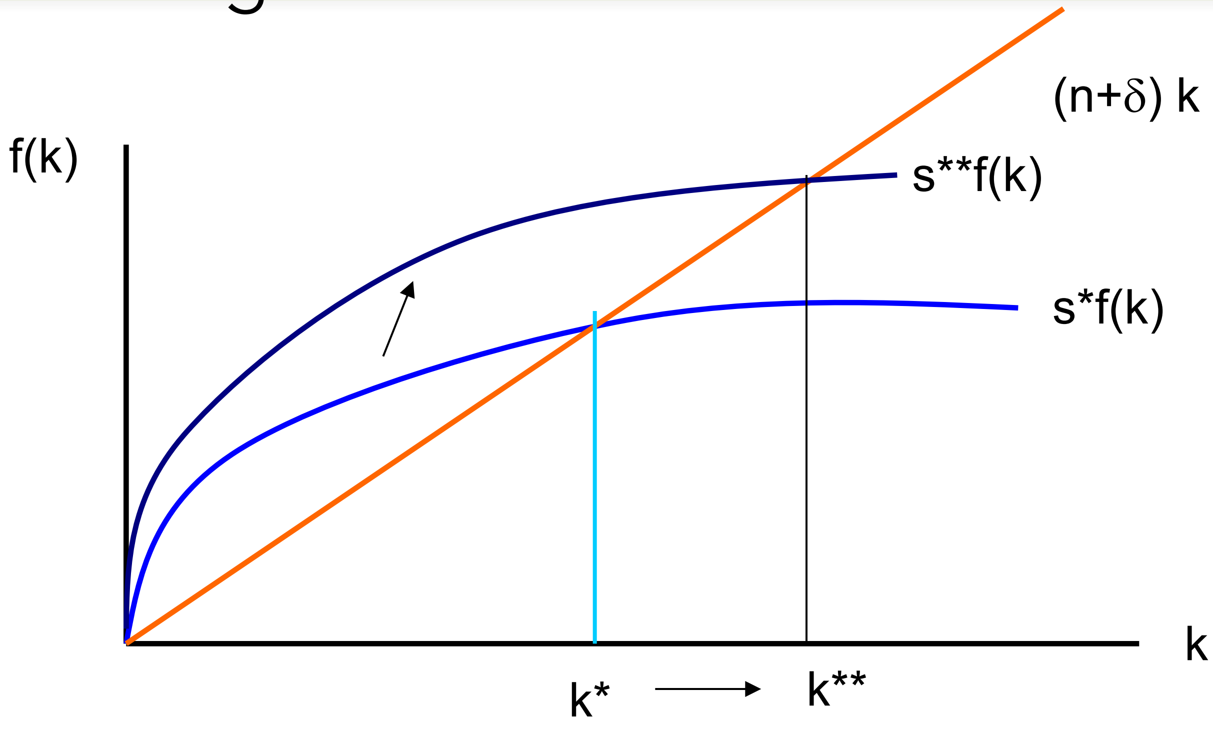
Graph

- Solow growth model



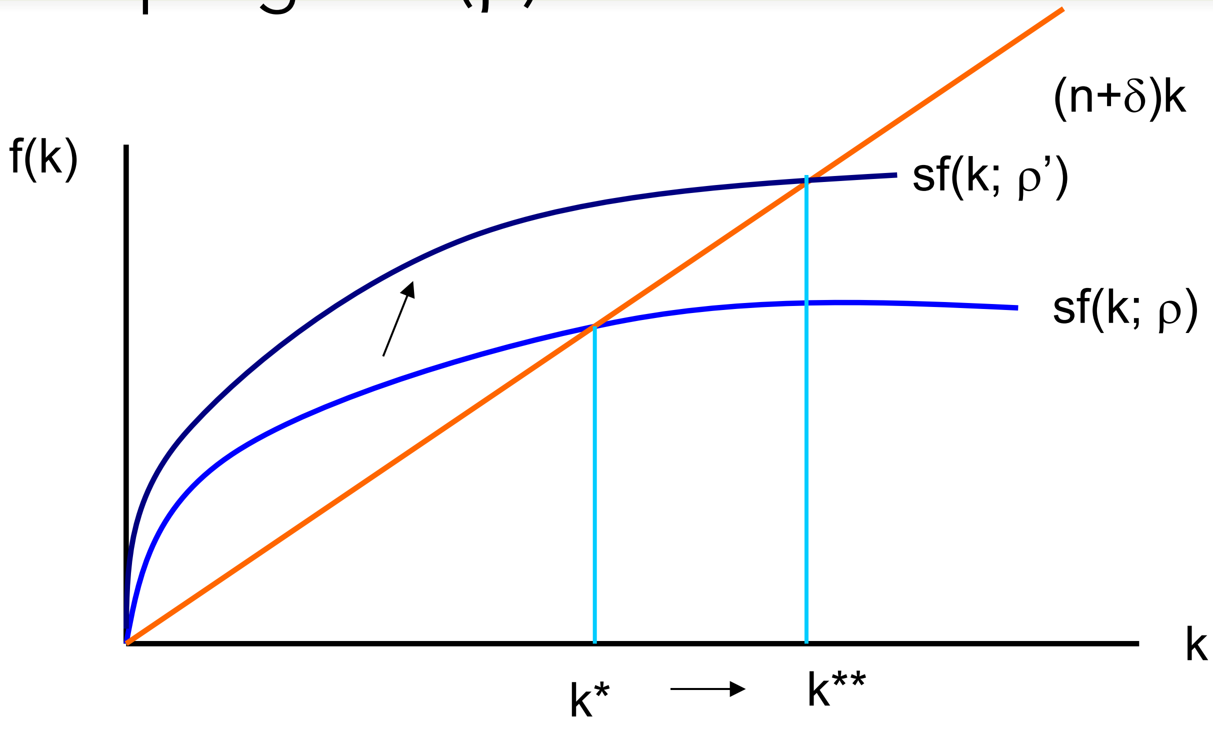
Graph

- Higher savings rate



Graph

- Technical progress (ρ)



Evaluation of the Solow model

- Empirically useful for growth accounting:
  - **Total factor productivity growth** (huge empirical literature)

- The long run prediction
  - Global **convergence** of per capita incomes
  - (Theoretically intriguing, but needs examination)

- Theoretical issue: **Sources of growth(?)**

- The factor productivity growth equation using Solow's growth model

Empirical usefulness

- The Solow model is useful in estimating technical progress, or productivity improvement.

- This is different from the growth of new jobs or capital goods. It is a component of GDP growth that is not accounted for by the growth of labour and capital use.

- GDP can grow if capital grows, and/or labour grows, and/or other input grows, and/or general productivity improves.

Empirical usefulness of the Solow model: Growth accounting

- Take a Cobb-Douglas production function:
- $Y_t = A_t K_t^{\alpha} L_t^{\beta}$, $0<\alpha, \beta<1$ →
- Growth rate of Y = **Growth rate of *A*** + α (growth rate of K use) + β (growth rate of L use)
-
- Object of interest: <u>Growth rate of *A*</u> (total factor productivity or TFP); this is estimated as a residual term, i.e. the **Solow residual**. → measuring <u>technical progress</u>

Derivation of the Solow growth accounting equation

- Write the Cobb-Douglas production function:
- $Y(t) = A(t)\, K(t)^{\alpha} L(t)^{\beta}, \qquad 0<\alpha, \beta<1$,

- Take natural logarithm
- $\ln Y(t) = \ln A(t) + \alpha \ln K(t) + \beta \ln L(t)$

- Differentiate with respect to *t*:
- $\frac{dY}{dt}\frac{1}{Y} = \frac{dA}{dt}\frac{1}{A} + \alpha \frac{dK}{dt}\frac{1}{k} + \beta \frac{dL}{dt}\frac{1}{t}$
- $g_Y = g_A + \alpha g_K + \beta g_L$

- $g_A = g_Y - \alpha g_K - \beta g_L$ [TFP growth equation]

Total factor productivity growth equation

- **Growth rate of *A*** = Growth rate of *Y* - α (growth rate of *K* use) -β (growth rate of *L* use)

- There are no data on *A* or factor productivity.

- But there are data on Y (i.e. GDP), K, L and other inputs (if any). In addition a and b can be estimated by the regression method.

- So by using the Solow equation one can measure the growth of total factor productivity.

Solow model in practice

- Many authors applied this model to a number of countries, and East Asia in particular.
- It is believed that the East Asian miracle was due to significant productivity growth.
- Not only did employment grow significantly, but also the productivity of labour also grew during the East Asian industrialisation.

But did productivity really grow in East Asia?

- Economist Young (1995) debunked the East Asian miracle by showing that the East Asian growth was largely from increased capital use rather than from productivity growth

- Data for four Asian economies over 1966-90

	Output growth rate (%)	TFP growth rate (%)
Hong Kong	7.3	2.3
Singapore	8.7	0.2
South Korea	8.5	1.7
Taiwan	8.5	2.1

Solow model elsewhere: Senhadji (2000) for 1960-94

- Total factor productivity growth is small in the developing world.
- It is fallen in Africa.
- Contribution of human capital is highest in L America

	Output growth rate (%)	TFP growth rate (%)	Contribution of human capital to output growth (%)
East Asia	6.49	0.28	6.77
South Asia	4.66	0.55	5.36
Sub-Saharan Africa	2.83	-0.56	7.77
M.& Nrth Africa	5.05	-0.03	4.95
Latin America	3.42	-0.39	8.18