

## Section Chapter 8: Growth Theory

### 1 Concept: Economic Model

Simplification of reality that captures a complex process that can explain the outcome of interest. Since it has to be a simplification, a model is always reductionist (many omitted details). However, all models need to be carefully assessed in terms of the validity of their assumptions relative to the field of analysis over which we would like the model to hold.

A model includes: (1) exogenous variables ( $X$ ) that fall into two categories: (a) uncontrolled variables such as weather, world economic context, and past events ( $X_1$ ), and (b) policy instruments, such as taxes and tariffs, public investment, technology and transfers ( $X_2$ ); (2) endogenous variables that represent the outcome of interest ( $Y$ ); and (3) a set of functions that relate  $Y$ ,  $X_1$ , and  $X_2$ .

The functions can be written in a structural form as  $h(Y, X_1, X_2)$  where they represent the assumptions of the model. They can also be written in reduced form as the solution to the model as  $Y = f(X_1, X_2)$ . In positive analysis, models are used to check on the logical structure of the reasoning and to estimate the functions  $h$  and  $f$ . In normative analysis, models are used for policy simulations and for predictions.

### 2 Harrod-Domar model

The objective of this model is to show how capital accumulation sustains growth and how savings and technology determine capital accumulation. This model assumes that capital is the limiting factor to output growth (not labor), and that there are constant returns to scale for each factor. Additional capital ( $\Delta K$ ) provides a constant proportional increase in output ( $\Delta Y$ ), referred to as the incremental capital output ratio:  $k = \frac{\Delta K}{\Delta Y} = ICOR$ . The higher the ICOR, the less productive is the technology.

1. Aggregate production function:  $\Delta Y = \frac{1}{k} \Delta K$
2. A savings function:  $S = sY$ , where  $s$  is the rate of savings
3. An investment function  $I = \Delta K = S$

$$\dot{Y} = \frac{\Delta Y}{Y} = \frac{1}{k} \frac{\Delta K}{Y} = \frac{1}{k} \frac{S}{Y} = \frac{s}{k}$$

Thus, the growth rate of the economy ( $\dot{Y}$ ) increases with the rate of savings ( $s$ ) and decreases with the ICOR ( $k$ ). Policy consequence: increase savings and/or lower ICOR.

| Country     | ICOR (k) | Rate of savings (s) | Rate of growth ( $\frac{\Delta Y}{Y}$ ) |
|-------------|----------|---------------------|---|
| U.S.        | 6        | 15%                 | 2.5%                                    |
| India       | 6        | 30%                 | 5%                                      |
| South Korea | 4        | 36%                 | 9%                                      |

The Harrod-Domar model has some limitations, namely that it does not allow for substitutions between capital and labor, decreasing returns to capital, and technological change. The Solow model tries to address these issues.

### 3 The Solow Growth Model

This model recognizes possible substitution between capital and labor in production. The model also captures that total factor productivity (TFP) gains play a major role in growth. This means that growth can come from factor deepening and/or from TFP growth (loosely, technological change).

The aggregate production function of the economy is  $Y = Af(K, L)$ . Because  $f$  has constant returns to scale, the production function can also be written as:  $\frac{Y}{L} = Af\left(\frac{K}{L}\right)$

The reduced form of the model gives the growth rate of output ( $\dot{Y}$ ):

$$\dot{Y} = \frac{\Delta Y}{Y} = \frac{\Delta A}{A} + w_K \frac{\Delta K}{K} + w_L \frac{\Delta L}{L}$$

where  $w_k = \frac{rK}{Y}$  is the share of capital in total cost, and  $r$  the price of capital, and  $w_L = \frac{wL}{Y}$  is the share of labor in total cost, and  $w$  the price of labor.  $\frac{\Delta A}{A}$  is the rate of technical change or TFP growth and  $\frac{\Delta K}{K}$ ,  $\frac{\Delta L}{L}$  are the rates of factor accumulation or factor deepening.

We measure the rate of technological change  $\frac{\Delta A}{A}$  as the **unexplained residual** from growth by taking the following difference

$$\frac{\Delta A}{A} = \frac{\Delta Y}{Y} - w_K \frac{\Delta K}{K} - w_L \frac{\Delta L}{L}$$

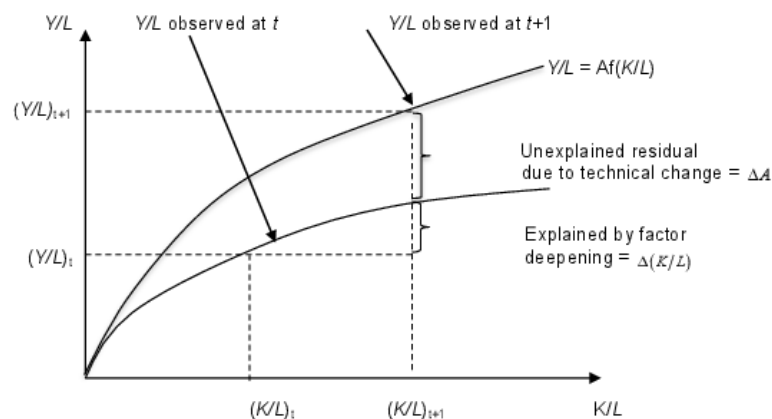


Figure 8.3. Factor deepening and productivity growth in the Solow model

**Solow model predicts convergence:** (1) Technology is an international public good to which all countries have equal access. (2) There are decreasing returns to capital and labor, so in the long-term, growth rate is defined by technology rather than factor-deepening. This implies long term income convergence between LDC and MDC. However, empirical studies only find selective convergence.

## 4 Dual economy models

Structural transformation: Agriculture declines as a share of the economy as the economy grows since it helps the rest of the economy accelerate its growth. The dual economy models help conceptualize this process.

$A$  = labor force in agriculture

$A^+$  = optimal labor force in agriculture

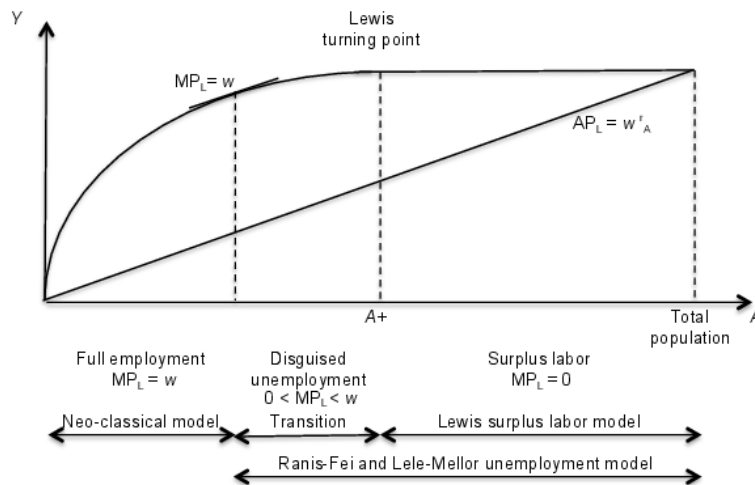
$\bar{W}_A^r$  = subsistence wage

$W_A = P_Y \bar{W}_A^r$  = nominal wage in agriculture

$W_M$  = nominal wage in industry

$\Delta$  = rural-urban migration cost

Wages in agriculture and industry are equalized by the process of migration:  $W_M = W_A + \Delta$



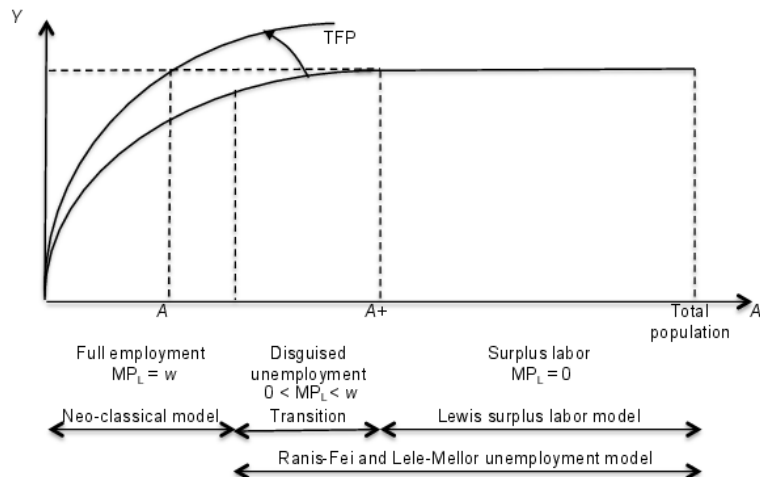
There are three basic approaches to model the a dual economy:

(1) **Lewis model (classical):**  $A > A^+$  because there is a labor market failure: rate of population growth in rural areas keeps  $W_A = \bar{W}_A^r$  (average wages equal to subsistence level), so workers can be drawn from country-side as long as  $W_M > W_A + \Delta$ , with no cost to economy

Policy consequence: **urban bias**

(2) **Jorgenson Model (neoclassical or full-employment model):** Once sufficient workers are removed from the agricultural sector,  $A = A^+$ , so removing additional agricultural workers will decrease food production which would raise real wages for industry, so to free labor from rural areas without decreasing food production, need to first increase TFP in agriculture

Policy consequence: **Green revolution is necessary for industrialization**



**(3) Unemployment and a role for agriculture (Ranis-Fei and Lele-Mellor models).**

Even without full-employment (more realistic assumption compared to neo-classical model), if there is free migration  $W_M = W_A + \Delta$ , so the wages in industry and agriculture are related. Productivity gains in agriculture reduce the nominal wage in industry, via lowering the price of food, since  $W_A = P_A \bar{W}_A^r$ . Key assumption: food prices depend on domestic production.

Policy consequence: **Green revolution can be good for industrialization even if there is surplus labor**