LECTURE 3

NEO-CLASSICAL *AND* NEW GROWTH THEORY

(N.B. LECTURE 3 AND 4 WILL BE PRESENTED JOINTLY)

Plan of lecture

A. Introduction

B. The Basic Neoclassical Growth Model

1. Comparative Statics
2. Testable Propositions
3. Main Critique of the Solow Model

C. New Growth Models

4. Main Traits of the New Models
5. Endogenizing savings, technological progress and long-term growth
6. Two examples of New Models

D. Convergence vs. Divergence

For the literature referred to, see last slide

[3.2] The Neoclassican Growth Model: Still of Relevance?

Main differences from the Harrod-Domar model: a) Labour in finite supply and b) Declining marginal productivity of capital

1) It is a **building block** for most of the **New Growth Theory** models**,** to be analysed subsequently, in all of which physical capital accumulation is one of the driving forces of growth.

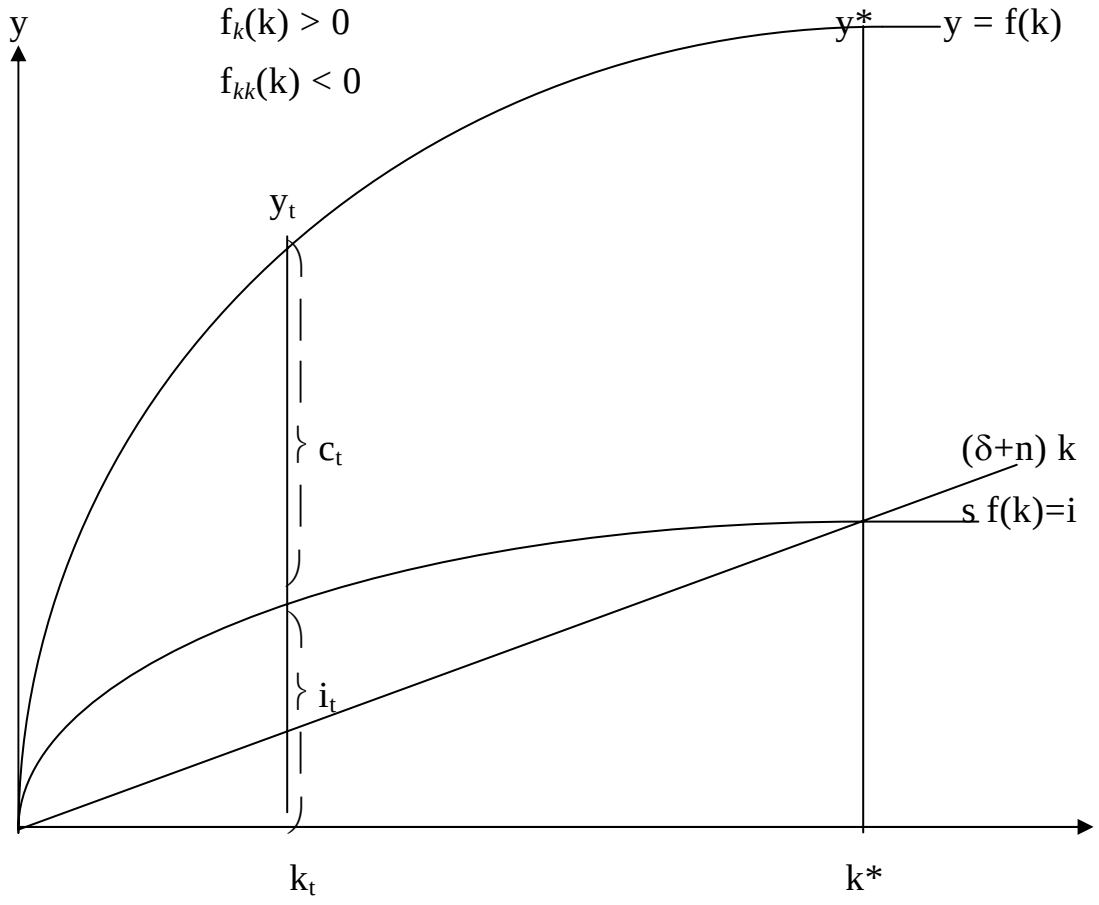
2) Some leading contemporary growth economists find it more **theoretically relevant** than "new theories" (e.g. Mankiw 1995).

3) Still the main base model for **empirical estimations** of growth determinants in the **individual country** (e.g. growth accounting).

4) It leads to a number of **testable propositions** that stand up quite well in empirical testing, especially for **developing countries**.

5) It leads to one prediction that seems especially relevant—and encouraging—in the developing country context, i.e. conditional **income convergence** across all countries in the long term.

[3.3] Figure 3.1: Basic Functions in Solow Model and Steady State



Assumptions:

(1) ***Y = f(K,L) (implies CRS)***

(1a) ***y = f(k,1) = f(k) (per capita)***

(1b) ***$f_k(k) > 0$ and $f_{kk}(k) < 0$***

(decreasing <u>marginal</u> returns to capital)

(2) ***i = sy (closed economy)***

(3) ***δk (depreciation of capital)***

(4) ***c = y - i***

Exogenous variables: s, δ, n, k_0

Endogenous variables: k, y and c

[3.4] Testable Propositions (cross-country)

A. Per-capita income level in Steady State

$$y^* = f[k^*(s, n, \delta)]$$

From the comparative statics **[3.4]** we have that:

a) $dk^*/ds > 0 \Rightarrow dy^*/ds > 0$

b) $dk^*/dn < 0 \Rightarrow dy^*/dn < 0$

c) $y^* \neq f(k_0)$,

which means steady state income independent of initial income, but varies with differences in savings/investment and population growth

[OH 3.5.a]

B. Growth of per-capita income below Steady State:

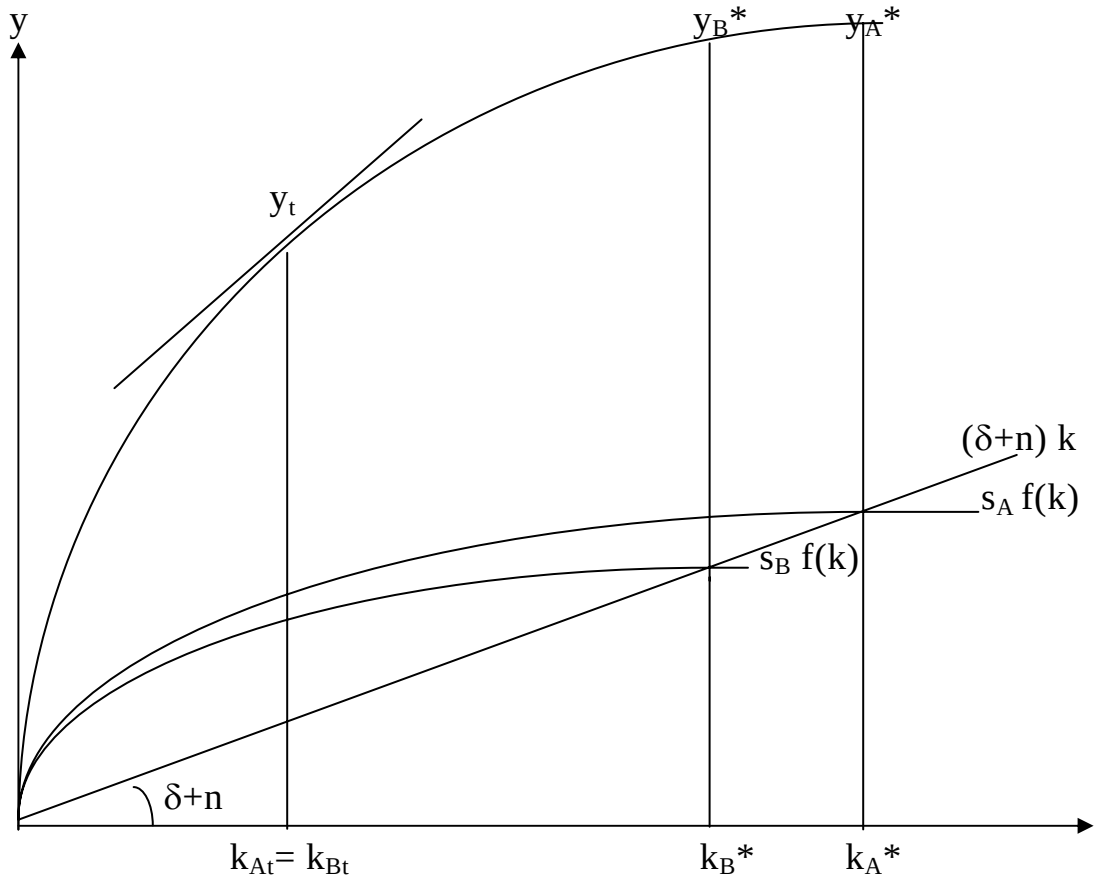
1) Countries with low initial capital stocks (and per capita income) have higher rates of per-capita income growth (since $f_{kk}(k) < 0$) than countries with larger capital stocks (cet. par.). $\Rightarrow$ conditional convergence of growth rates when steady state is reached.

2) For given capital stock below steady state (and hence income): (a) the savings/investment ratio and

(b) the population growth rate, do not affect the income *growth rate*

[OH 3.5.b]

[3.5.a] Figure 3.2: Comparative Statics and Steady States

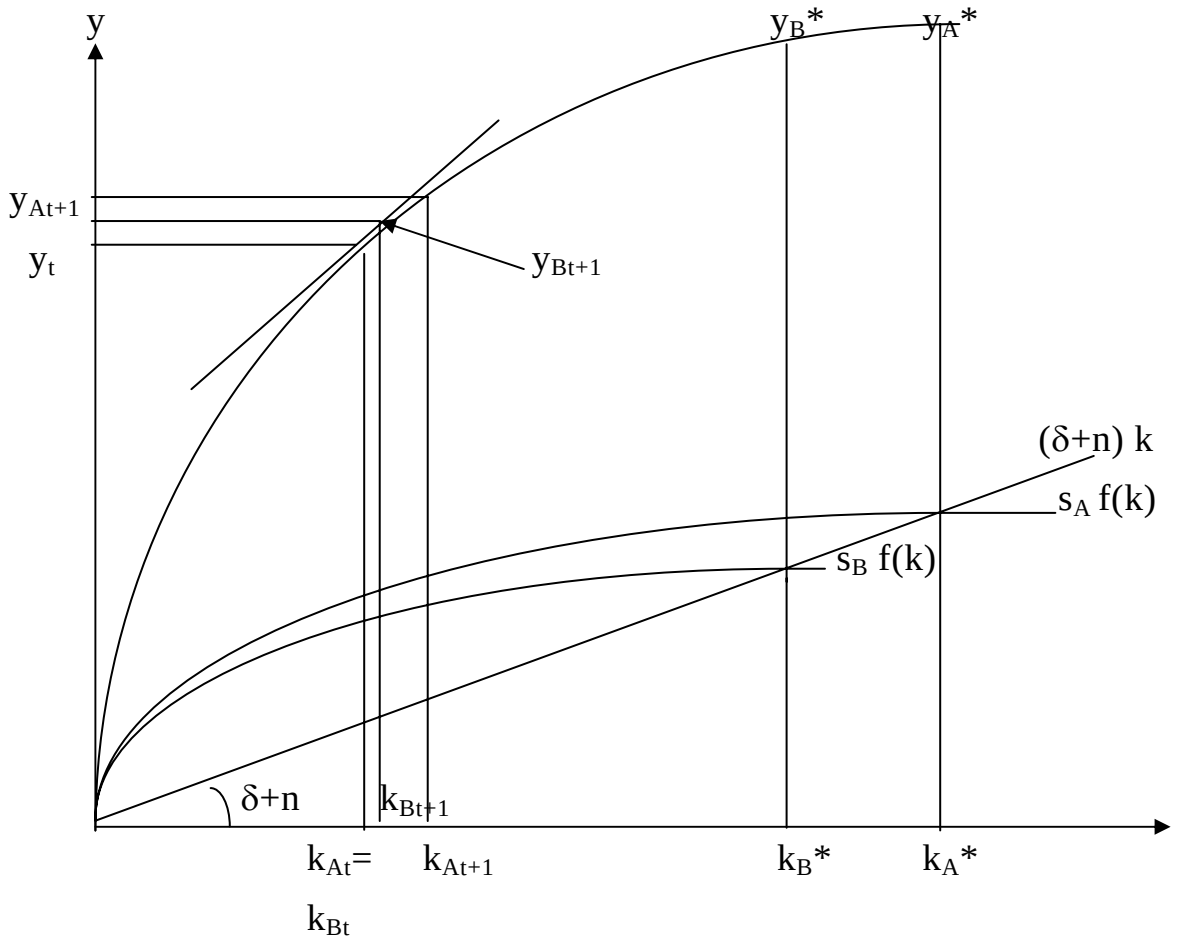


Growth of per-capita income at steady state can only follow from <u>exogenous</u> technological progress

[3.5.b] Figure 3.2: Comparative Statics below Steady State

A standard prediction of the Solow model is hence that differences in savings and investment ratios do not affect growth rates, only steady state income

Qualification: applies only to infinitely small differences!



In empirical work, based on annual data, we hence expect savings/investment differences to affect growth rates

[3.6] *Critique of the Solow Model*

Theoretically

* **Technological progress is exogenous** (not explained) while at the same time, technical progress is the only variable in the model that gives raise to per-capita growth in the long term (i.e. equal in each country in steady state), but at different levels of income (conditional upon savings, population growth, etc.).

* **Savings/investment**, the crucial variable explaining what level of steady state income different countries reach, is also **exogenous**.

* The Solow model does not incorporate **human capital**, which both common sense and new growth theory would say is important for growth.

Empirically

(to be elaborated in lecture 4)

* **Weak empirical evidence of a convergence** towards a uniform growth rate among the world's economies.

* When estimated values of the various parameters are inserted in the Solow model, the simulated results are **implausible**

[3.7] *Traits in New Growth Theory*

1. **<u>Endogenizing</u> variables**

   a) Savings/Investment (adding a demand side with inter-temporal consumption preferences)

   b) Technological progress and skill formation

   c) Population growth (lecture 5)

   d) Long-term per-capita growth

2. **<u>Extensions</u> of Model to take into account:**

   a) Multi-sector models

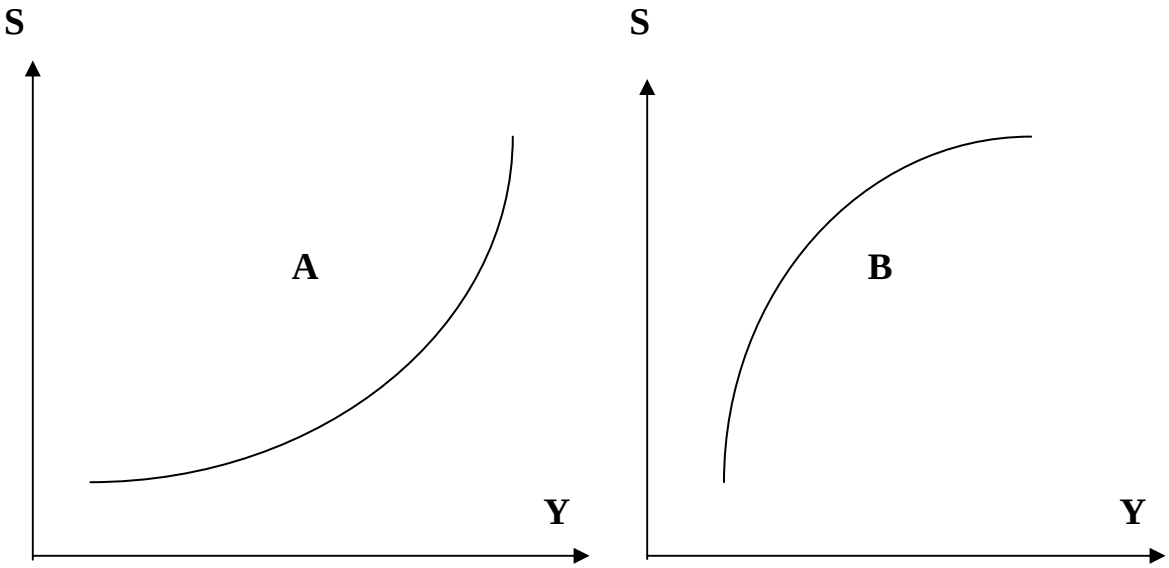
   b) More factors of production, externalities and economies of scale, monopolistic competition

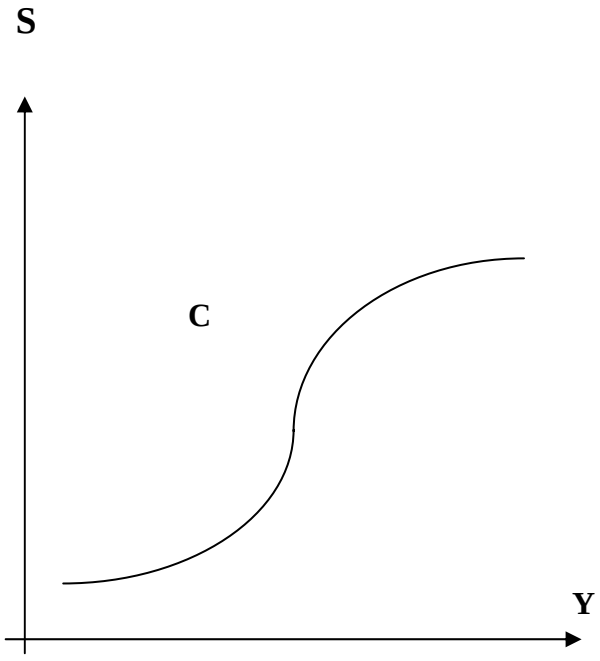
   c) Open economy models (e.g. Edwards)

   (touch upon in lecture 9).

[3.8] *Endogenising Savings* *(e.g. Ray, pp. 211-215)*

Figure 3.4: Different possible savings functions





Solow: Savings exogenous and *constant* over the growth process

Alternative: S=f(r, y),where r is the return to capital and y is per-capita income. Both these variables are endogenous in the Solow model (i.e. they change with growth).

There is hence one *income* efffect (of y) and one *subsituation* effect (of r) on savings.

Excercise: The income and substitution effects tend to go in different directions

Which of the ”pictures” (A, B or C) of the savings function would follow if the income effect dominates?

If the substitution effect dominates?

[3.9] *New Growth Model 1*: Endogenous technological progress (see Ray, chapter on growth)

We have an economy with **two** sectors. In the sector producing ordinary goods, we have a production function with **three** factors of production:

$$\mathbf{Y_t = E_t^{\gamma} K_t^{\alpha} [\, \mu H \,]^{(1-\alpha)}} \qquad (1)$$

* $\mathbf{E_t}$ is the amount of technical know-how in the economy at date t,
* $\mathbf{K_t}$ is the stock of physical capital at date t,
* **H** is a ***given*** stock of human capital (no time index)

μ is the share of this human capital stock that is devoted to the production of final goods. and $(1-\mu)$ is thus the share devoted to the production of new technological know-how in the know-how producing sector. γ, α, and $(1-\alpha)$ are the output elasticities of the factors.
NB: **If $[\gamma + \alpha + (1-\alpha)] > 1$, there is economies of scale, implying divergence**

In this sector, capital grows the same way as in the Solow model:

$$\mathbf{K_{t+1} - K_t = sY_t} \qquad (2)$$

We also have a sector producing knowledge with only one factor of production (H):
The growth of knowledge in this sector is determined as:

$$\mathbf{(E_{t+1} - E_t)/E_t = a(1-\mu) H} \qquad (3)$$

where a is a positive constant and $(1-\mu)$ is the share of the given human capital stock that is employed in this sector. Share of μ (policy variable) and size of H (exogenously given) determine growth of knowledge and hence income!

[3.10] *New Growth Model 2*: Human Capital

One sector economy with two factors of production: (1) physical capital; (2) human capital. Simple production function of the Cobb-Douglas type:

$$y_t = k_t^{\alpha} h_t^{(1-\alpha)} \quad \text{(income level)} \qquad (1)$$

$$y_t = c_t + s_t + q_t, \qquad (2)$$

Same type of physical capital accumulation as in the Solow model:

$$k_{t+1} - k_t = sy_t \quad \text{and} \qquad (3)$$

$$h_{t+1} - h_t = qy_t \qquad (4)$$

After some manipulation (see Ray, pp. 100-102 and 125-126), we can show that the rate of growth is determined as follows:

$$(y_{t+1} - y_t)/ y_t = s^{\alpha} q^{(1-\alpha)} \quad \text{(income growth rate)} \qquad (5)$$

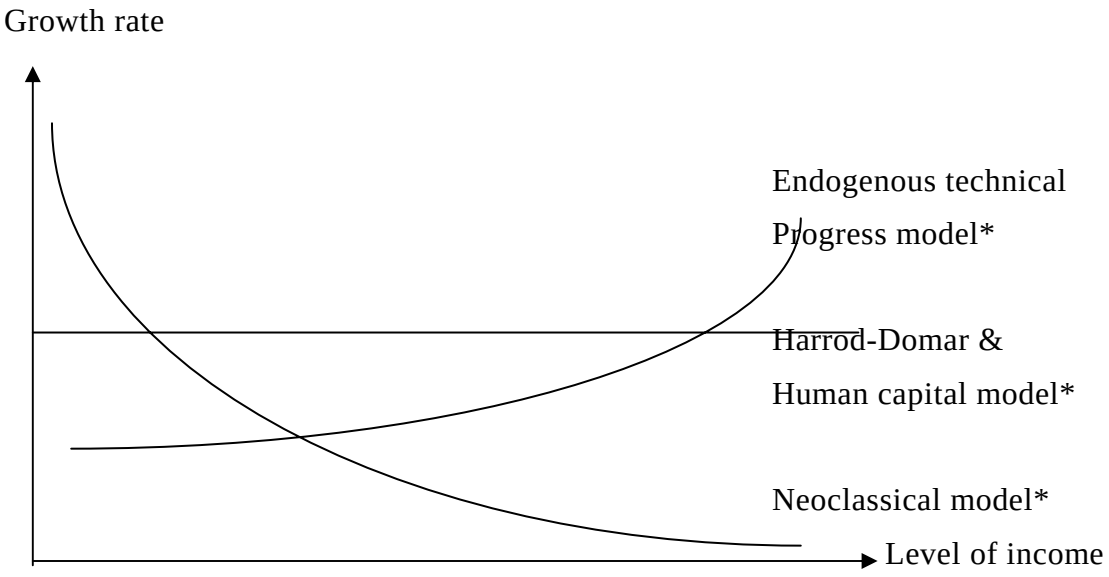
That is, the growth rate is determined by (i) the two savings/investment ratios and (ii) the output elasticities.

To note (Ray, pp. 102-105):

1. There may be declining returns to physical capital, but still **no convergence**. This is because there is **constant returns to scale** for physical and human capital in fixed **combination**.

2. Savings (s and q) have **growth effects** (as in the H-D model), not only **level effects** as in the Solow model in steady state. That is, growth is determined **endogenously** in the model (but notice that s and q are **exogenous**)

[3.11] Different models predict growth rate convergence, divergence or neutrality



* Conditional upon that the exogenous variables are identical across countries; if not, other results emerge

Summary points on growth theory

1) All the growth models have accumulation of **physical capital** as one of the mechanisms driving growth, from H-D to new growth models.

2) They differ, though, in what is **assumed** to be **exogenous/ endogenous**, **scale economies**, and the role of **human capital**.

3) Some models predict that growth will **decline** with higher income levels (neoclassical), some that growth rate will be **neutral** and still others that it will **accelerate** with higher incomes.

It is hence an empirical issue to find out which set of models that has the best predicative power (lecture 4).

Mandatory reading:

Ray, D. (1998), *Development Economics*, pp. 64-94, 102-05 and 211-15.

Mankiw, N.G. (1995), "The Growth of Nations", *Brookings Papers on Economic Activity*, 1:1995

Literature referred to:

Jones, C.I.(2002), *Introduction to Economic Growth* (second edition), Norton.

Easterly, W. (2001), *The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics*, Cambridge: The MIT Press.