Lecture 3

Economic Growth: Theory and Empirical Patterns

(Digression based on Chapter 2 of Perkins et al.)

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Technical Progress in Solow Model …. 1

- A new variable:
  - ***E*** = labor efficiency
- Assume:
  - Technological progress is **labor-augmenting**: it increases labor efficiency at the exogenous rate ***g****:*

$$g = \frac{\Delta E}{E}$$

Technical Progress in Solow Model …. 2

- New production function.
  - Y = F(K, L x E)
  - $\boldsymbol{L} \times \boldsymbol{E}$ = the number of effective workers.

- Implication.
  - Increases in labor efficiency have the same effect on output as increases in the labor force.

Technical Progress in Solow Model …. 3

- New notation.
  - k = K/LE Capital per effective worker
  - y = Y/LE Output per effective worker
    - y = f(k)

- New capital requirement at steady state.
  - δk Replacement capital for depreciation
  - nk Capital for new labourers
  - gk Capital for “new” effective labourers created by technical progress

- Savings.
  - s = sy = sf(k)

Technical Progress in Solow Model …. 4

- Steady state.
  - $sf(k^*) = (\delta + n + g)k$
- Growth at steady state.
  - Capital per effective labourer = 0
  - Output per effective labourer = 0
  - Output per labourer = g
  - Total output = n + g
- New golden rule.
  - $MPK(k^{**}) = \delta + n + g$

How Reasonable is the Solow Model? …. 1

- Implication.
  - Convergence of per capita GDP.
- Testable proposition.
  - Is growth rate of per capita GDP inversely related to the initial level of GDP?
- Evidence.
  - Post WW-II growth in per capita GDP largely uncorrelated with initial level of per capita GDP.

How Reasonable is the Solow Model? …. 2

- Fallacy.
  - Accounting for technical progress.
- Measure of technical progress.
  - Primary and secondary school enrolment rates.
- Empirical result.
  - Conditional convergence.

How Reasonable is the Solow Model? …. 3

- Determinants of economic growth.
  - Barro and Sala-i-Martin (NBER, Working paper 3120, 1989)
  - Mankiw, Romer and Weil (QJE, v. 107, n. 2, p. 407-437)
  - Initial income level (-)
    - Conditional convergence.
  - Life expectancy (+, causality?)
  - Education level (+, weak)
    - Solow model (“technology” and capital deepening)
  - Geography
  - Savings and investment (+)
    - Harrod-Domar and Solow models.
  - Trade and exchange rate policies
  - Natural resource endowments (Africa?)
    - Griffin and Gurley (JEL, v. 23, n. 3, p. 1089-1143)
  - Political instability (-)

Solow's Legacy: Real Business Cycle Models …. 1

- Production constraint.
  - $i_t + c_t \leq a_t f(k_t, n_t)$
- Capital accumulation.
  - $k_{t+1} = (1 - \delta)k_t + i_t$
  - $k_{t+1} = (1 - \delta)k_t + a_t f(k_t, n_t)$
- Utility function.
  - $u = \Sigma_0^{\infty} \beta^t u(c_t), \quad 0 < \beta < 1$
    - $u = u_1 + u_2/(1 + \beta)$
  - $E(u) = E[\Sigma_0^{\infty} \beta^t u(c_t, l_t)]$

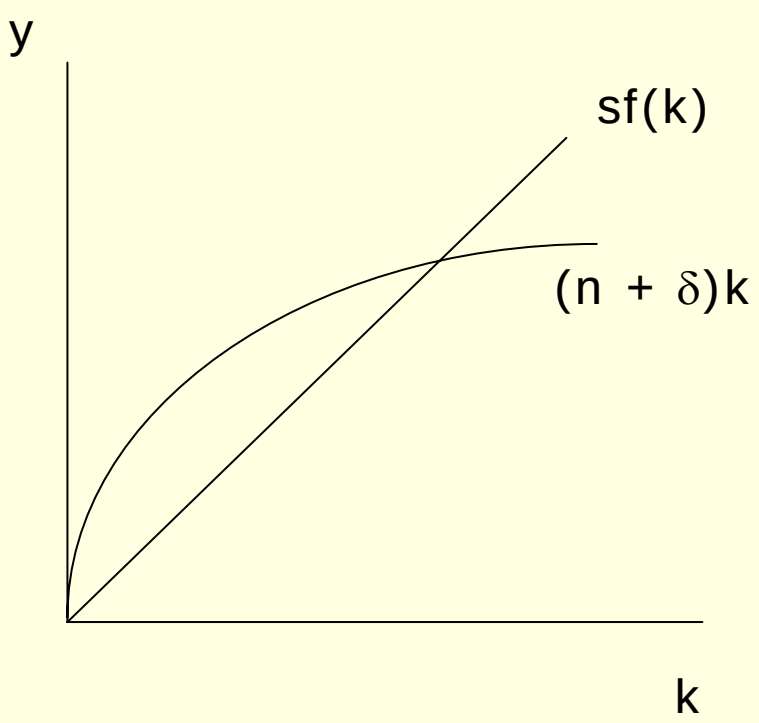
Solow's Legacy: Real Business Cycle Models …. 2

- Producer's problem.
  - Maximise profits subject to production constraint.
    - Choice variables: k and n.
      - Demand for factors of production.
      - Supply of output.

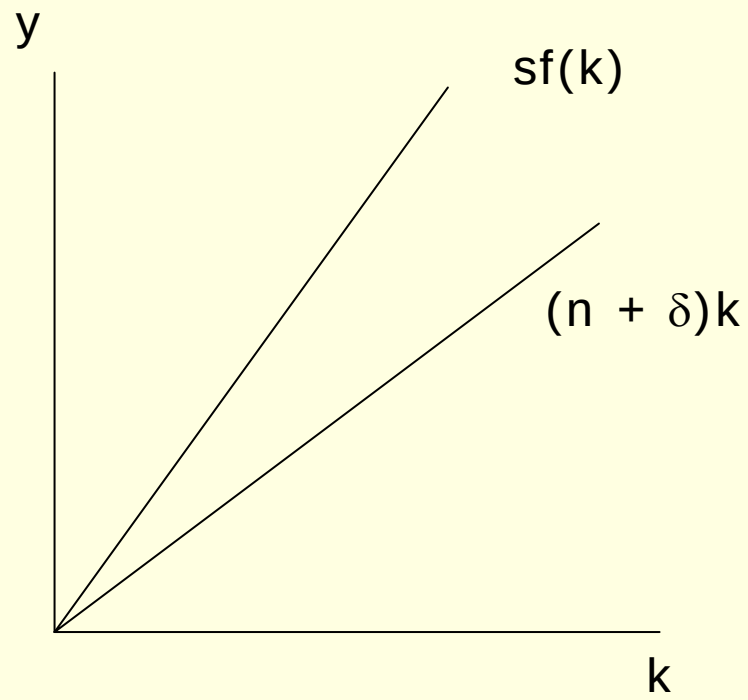
- Consumer's problem.
  - Maximise expected utility subject to budget constraint and endowment constraint.
    - Choice variables: consumption-saving, labour-leisure
      - Supply of factors of production.
      - Demand for output.

Endogenous Growth Model …. 1

- Diminishing marginal productivity of capital



- Constant marginal productivity of capital



Endogenous Growth Model …. 2

- Production function:
  - $Y = aK$
- Assumptions:
  - No change in population.
  - No depreciation.
- Capital accumulation:
  - $\Delta K = sY = saK$
  - $\Delta K/K = sa$
- Economic growth:
  - $g = \Delta Y/Y = \Delta K/K = sa, \quad dg/da > 0$

Endogenous Growth Model …. 3

- Problem:
  - Constant marginal productivity of capital implies increasing returns to scale overall.
    - Rationale for existence of monopolies.
- Solution:
  - A firm does not capture all the benefits associated with an increase in capital.
    - Rationale for having more than one firm.

Total Factor Productivity …. 1

- Intuition.
  - The proportion of growth rate that cannot be explained by factor inputs.
- Problems.
  - What determines total factor productivity?
    - Less corruption?
    - Better policies?
    - New technology?
  - How can we filter out the impact of errors and omissions in the data?

Total Factor Productivity …. 2

- Measurement:
  - Partial indices:
    - APL = Q/L
    - APK = Q/K
  - Total productivity indices:
    - $A = Q/(w_1L + w_2K)$

- Solow's measure of TFP:
  - Cobb-Douglas production function.
  - Constant returns to scale.
  - $dA/A = [dQ/Q] – [\alpha(dL/L) + (1 - \alpha)(dk/K)]$
    - Totally differentiate and then divide by Q.

Total Factor Productivity …. 3

- Measurement problem.
  - TFP is the residual of an econometric estimation.
    - LHS = output; RHS = labour and capital
  - Possible source of errors:
    - Measurement of L and K.
      - Cambridge vs. Cambridge debate about measurement of capital.
    - Misspecification.

- Determinants of TFP.
  - Technical characteristics of the production process.
  - Movement of relative factor prices.
    - Ability to substitute between L and K.

Total Factor Productivity …. 4

- Determinants of technical characteristics:
  - Efficiency of production.
  - Bias in the technical change.
  - Elasticity of substitution.
  - Scale of operations.
  - Homotheticity of production function.

- Impact of changes in relative price.
  - Change in K/L.

Total Factor Productivity …. 5

- Stylised empirical methodology.
  - L = number of labourers
  - K = dollar value of capital stock

- Modelling TFP.
  - Quality of labour.
  - Quality of capital.
  - Extent of competition.
  - Ownership.