

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.
 - $Y = F(K, L \times E)$
 - $L \times E$ = 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.
 - $u = \sum_0^\infty \beta^t u(c_t), \quad 0 < \beta < 1$
 - $u = u_1 + u_2 / (1 + \beta)$
 - $E(u) = E[\sum_0^\infty \beta^t u(c_t, l_t)]$

Solow's Legacy:

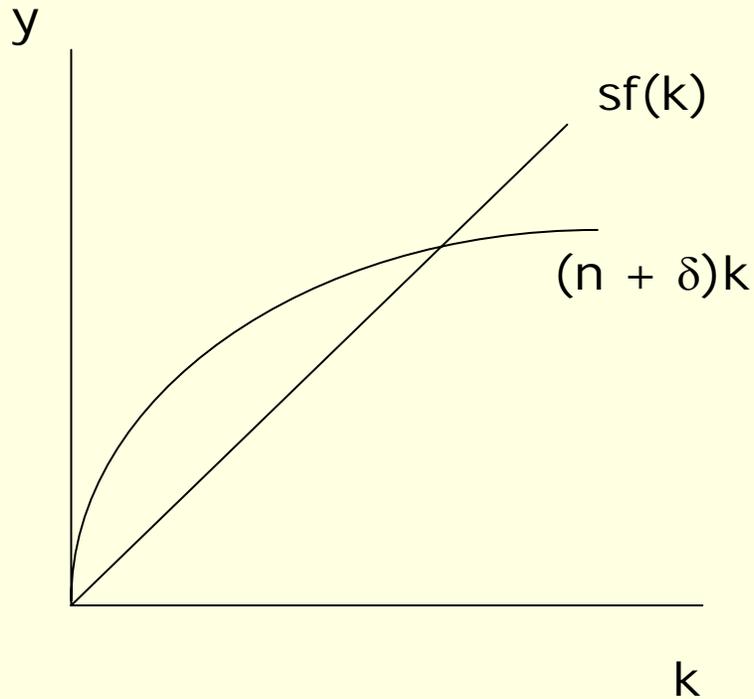
Real Business Cycle Models 2

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

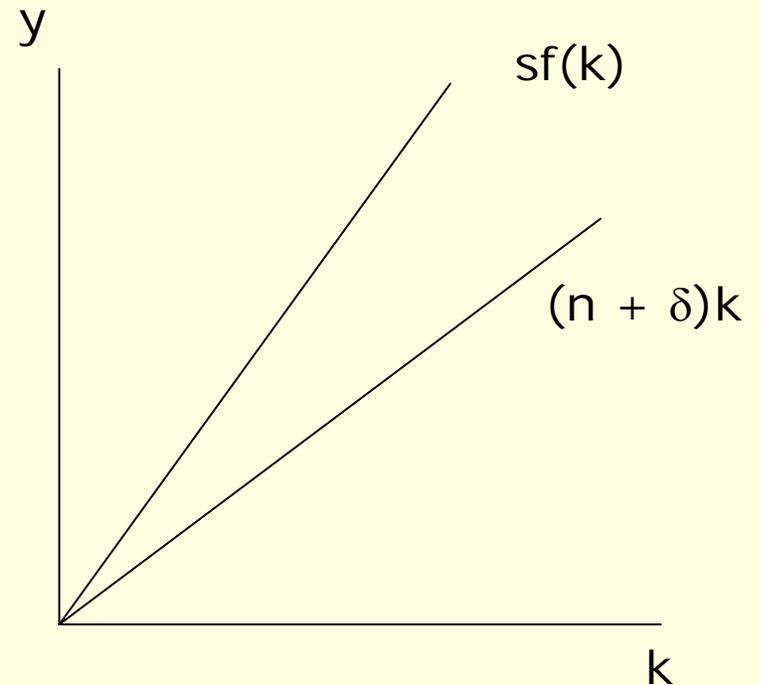
- Consumer's problem.
 - Maximise expected utility subject to budget constraint and endowment constraint.
 - Choice variables: consumption-saving, labour-leisure
 - Supply of factors of production.
 - Demand for output.

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.