

## Lecture 2

# Economic Growth: Theory and Empirical Patterns

(Based on Chapter 2 of Perkins et al.)

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# Recap

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- Basic growth model.
  - Growth comes through addition to capital stock and stock of labour force.
- Harrod-Domar growth model.
  - Growth comes through savings.
  - Restrictive assumptions.
    - Constant coefficient production function.
    - Constant capital-output ratio.

# Solow Growth Model .... 1

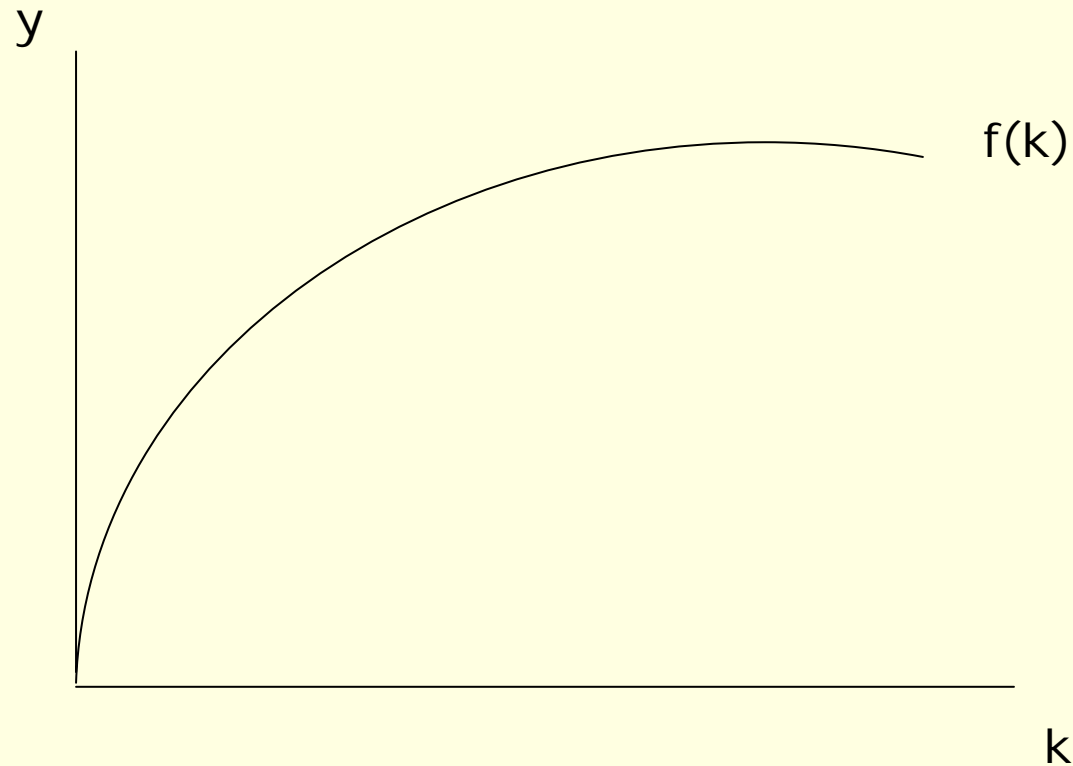
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- Neo-classical production function.
  - Allows substitution between labour and capital based on availability.
  - Production function.
    - $Y = F(K, L)$
    - $Y/L = F(K/L, 1)$
    - $y = f(k),$

$$y = Y/L, k = K/L$$

# Solow Growth Model .... 2

- Assumption: Diminishing returns to capital.



# Solow Growth Model .... 3

- We know:

- $\Delta K = sY - \delta K$  [1]

- $\Delta K/K = (sY/K) - \delta$  [2]

- $\Delta k/k = \Delta K/K - \Delta L/L$  [3]

- $\Delta K/K = \Delta k/k + \Delta L/L$  [4]

- $\Delta L/L = n$   
[5]

- $\Delta K/K = \Delta k/k + n$  [6]

# Solow Growth Model .... 4

- [2] + [6]
  - $(sY/K) - \delta = \Delta k/k + n$   
[7]
  - $\Delta k/k = (sY/K) - \delta - n$   
[8]
  - $\Delta k = (sY/K)k - \delta k - nk$  [9]
  - $\Delta k = (sY/K)(K/L) - (\delta + n)k$  [10]
  - $\Delta k = (sY/L) - (\delta + n)k$   
[11]
  - $\Delta k = sy - (\delta + n)k$  [12]

- Basic equation [12].

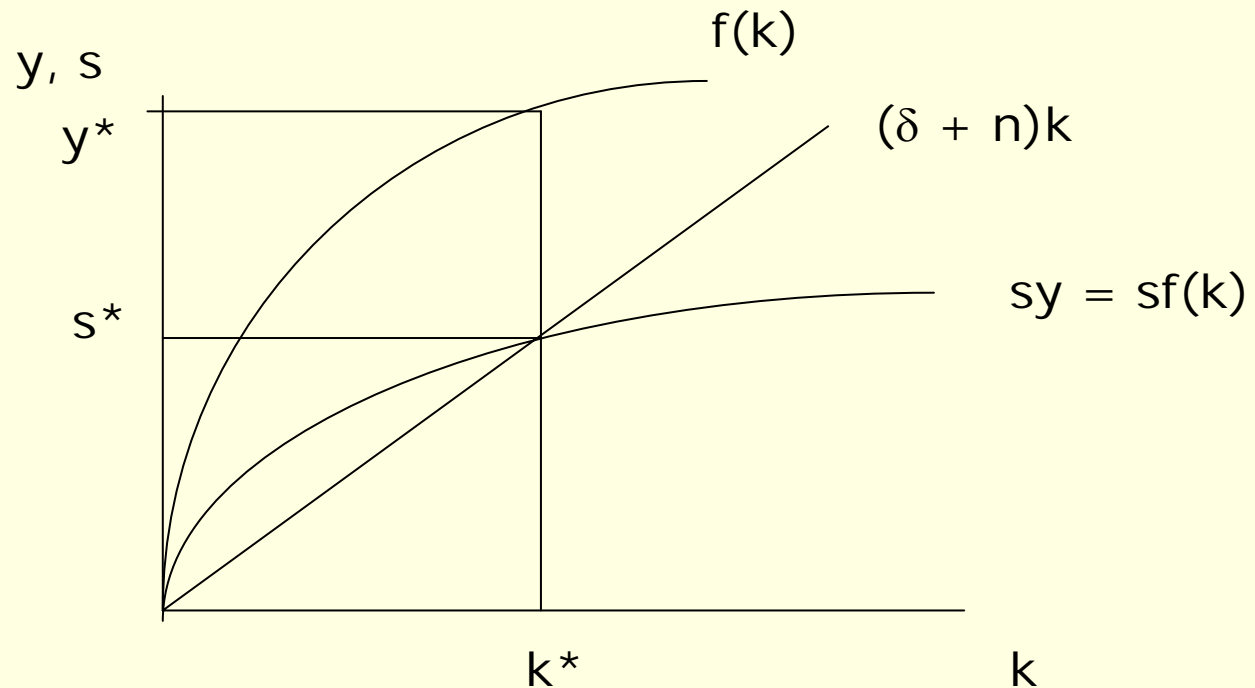
# Solow Growth Model .... 5

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- Implications of basic equation.
  - $\Delta k$  is positively related to savings (or investment) per labourer.
    - $d \Delta K/ds > 0$
  - $\Delta k$  is negatively related to population growth.
    - $d \Delta K/dn < 0$
  - $\Delta k$  is negatively related to the depreciation rate.
    - $d \Delta K/d \delta < 0$

# Solow Growth Model .... 6

- Solow model.
  - $y = f(k)$
  - $\Delta k = sy - (\delta + n)k$





# Solow Growth Model .... 7

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- We know:
  - Amount of savings available =  $sy$
  - Amount of savings required to account for depreciation and population growth =  $(n + \delta)k$
  
- Steady state.
  - $sy = (n + \delta)k$ 
    - $k$  constant
    - $y$  constant
    - $s$  constant

# Solow Growth Model .... 8

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- $sy > (n + \delta)k$ 
  - Capital deepening.
  - Accelerated growth.
  - Rise in output per labourer.
  
- $sy < (n + \delta)k$ 
  - Decline in capital per labourer.
  - Decline in growth.
  - Decline in output per labourer.

# Solow Model .... 9

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- Implication of Solow model.
  - High  $k$  implies that a high level of investment is required to maintain the capital-labour ratio.
  
- Problem.
  - Investment may crowd out consumption.
  
- Golden rule.
  - Consumption at steady state
    - $c(k^*) = f(k^*) - (n + \delta)k^*$
  - Maximisation of consumption.
    - $MPK(k^{**}) = n + \delta$

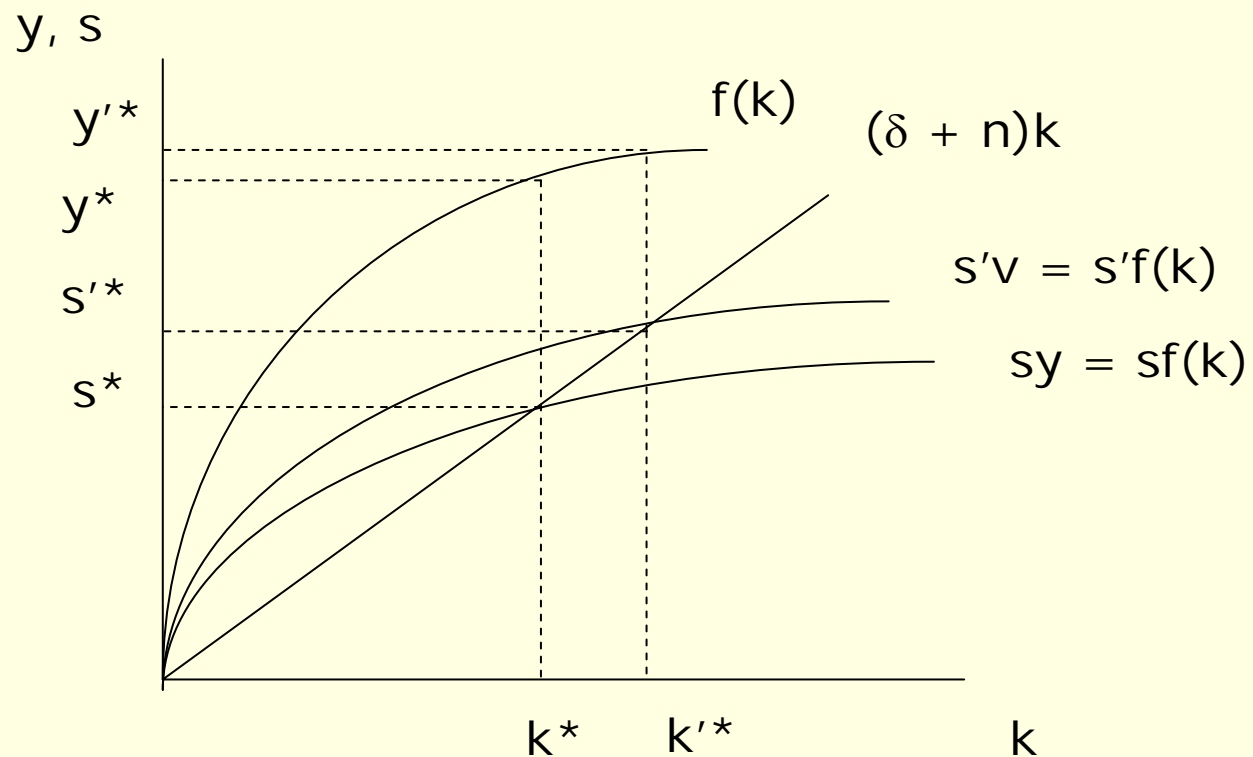
# Solow Growth Model .... 10

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- Implication of shape of  $f(k)$  curve.
  - A country with low capital stock can benefit more from adding to its capital stock than a country with large capital stock.
    - If a developing country saves it can grow faster than a developed country and eventually catch up with it.
      - Barro and Sala-i-Martin.
  
- What happens if the following change in the Solow model?
  - Savings rate
  - Population growth
  - Technology

# Solow Growth Model .... 11

- Increase in savings rate.
  - Compare with Harrod-Domar model.



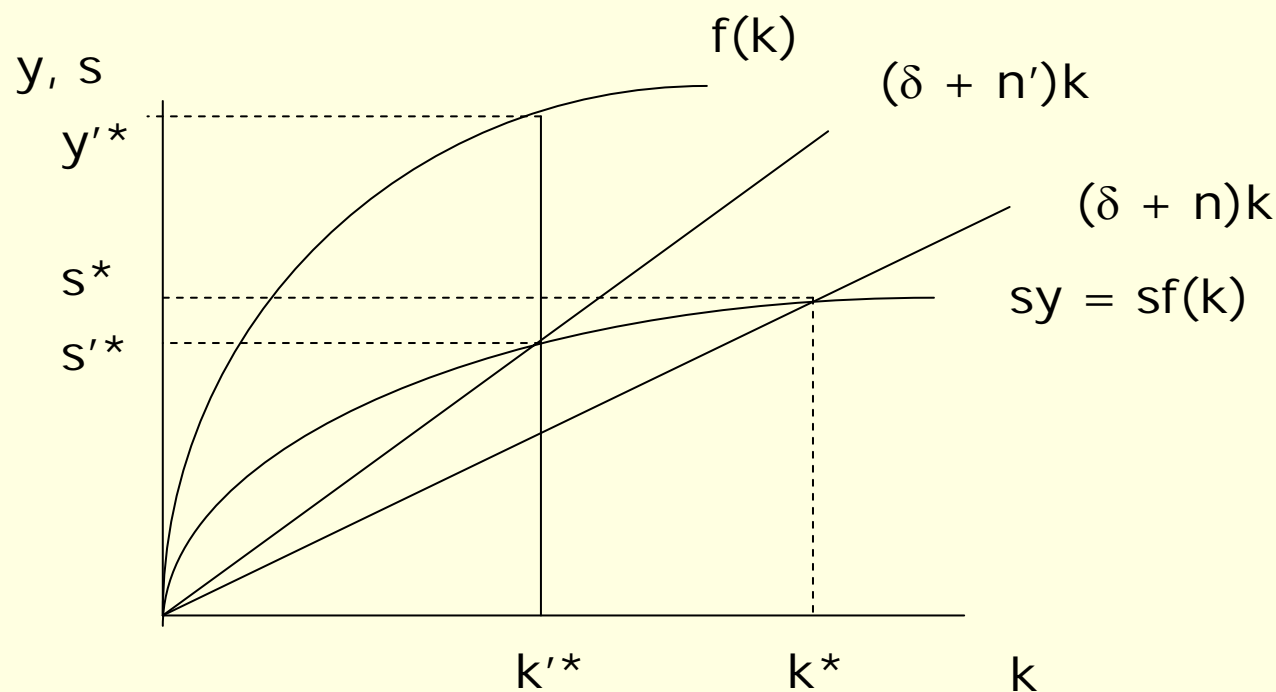
# Intuition .... Rise in Savings Rate

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- Rise in savings / investment per worker.
- Rise in capital per worker.
- Rise in growth rate.
  - Rise in growth rate less than proportional to rise in capital per worker.
    - Decreasing returns to scale.
      - Compare with Harrod-Domar model.
- Economy moves to a higher  $\{k, y\}$  steady state permanently.

# Solow Growth Model .... 12

- Rise in growth rate of population.
  - Compare with Harrod-Domar model.



# Intuition .... Rise in Population Growth

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- Fall in savings / investment per worker.
- Fall in capital per worker.
- Fall in growth rate.
  - Compare with Harrod-Domar model.
- Economy moves to a lower  $\{k, y\}$  steady state permanently.



# Implications

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- Two identical countries may have different growth rates if they differ.
  - Different savings rates.
    - East Asia vs. Africa. (True / False?)
      - Ando and Modigliani (AER, v. 53, n. 1, p. 55-84)
      - Ando and Modigliani (AER, v. 54, n. 2, p. 111-113)
  - Different rates of growth of population.
    - China vs. India (True / False?)
  
- The country with the lower steady state growth rate can catch up, but it may take years.

# Puzzle

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- The US has very low savings rates.
  - Is it low or high relative to EU?
- The US has higher population growth than the EU.
- The US grows faster than the EU.

# Solution

- Technological change.

