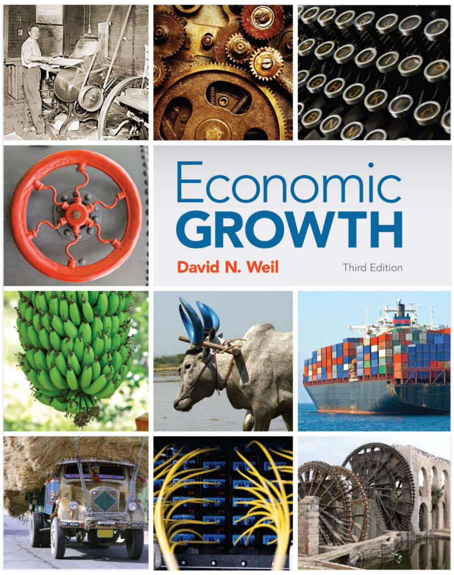
Chapter 3

# PHYSICAL CAPITAL

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## Nature of capital

- Capital is productive
- But it is has been produced itself…through investments. In other words capital is accumulated. Distinction between flows and stocks
- Capital depreciates
- Capital stock is made of machinery, tools, buildings, roads….
- It can private or public (mainly infrastructures)

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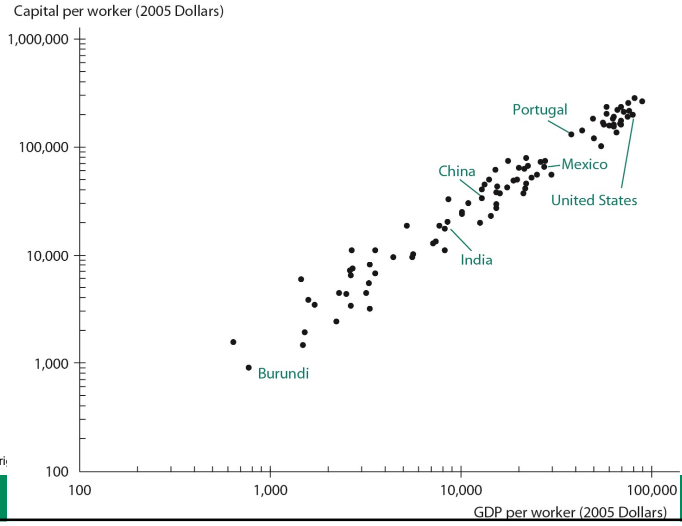
## **An interesting stylised fact:** GDP and Capital per Worker, 2009




*Source*: Calculations based on Heston et al. (2010).

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## Early models of economic growth

- Harrod-Domar model
- Solow model

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# Capital's role in production

- Production function:
  - Y=F(K,L)
  - Y/L=F(K/L, 1)
  - y= f(k)

NOTE: in a competitive environment alpha is the capital factor share, in a Cobb-Douglas model this is constant

SOLOW model: Cobb-Douglas PF

- $Y=F(K,L) = AK^{\alpha}L^{\beta}$
- Usually $\alpha+\beta=1$ (assumption of no economies of scale), in this case we can rewrite the function above as follows:
- $Y=F(K,L) = AK^{\alpha}L^{1-\alpha}$ , which is also in per capita terms
- $y = A\,k^{\alpha}$

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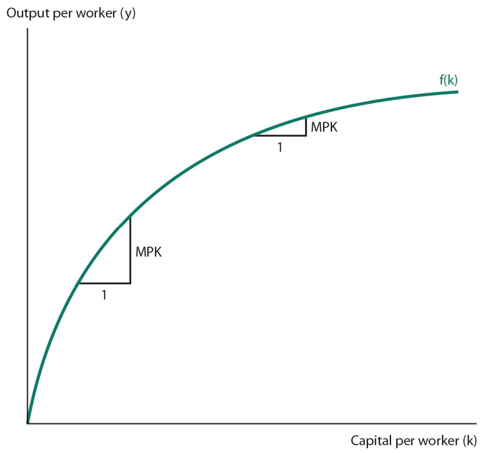
# Solow model: A Production Function with Diminishing Marginal Product of Capital

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# Capital's role in production

In a competitive environment, where factors are paid according to marginal productivity,

$\alpha$ is the capital factor share, and in a Cobb-Douglas model this is constant:

$$MPK = \alpha A K^{\alpha-1} L^{1-\alpha}$$

– Quota of income to capital:

– $(MPK*K)/Y = (\alpha A K^{\alpha-1} L^{1-\alpha} * K)/A K^{\alpha} L^{1-\alpha} = \alpha$

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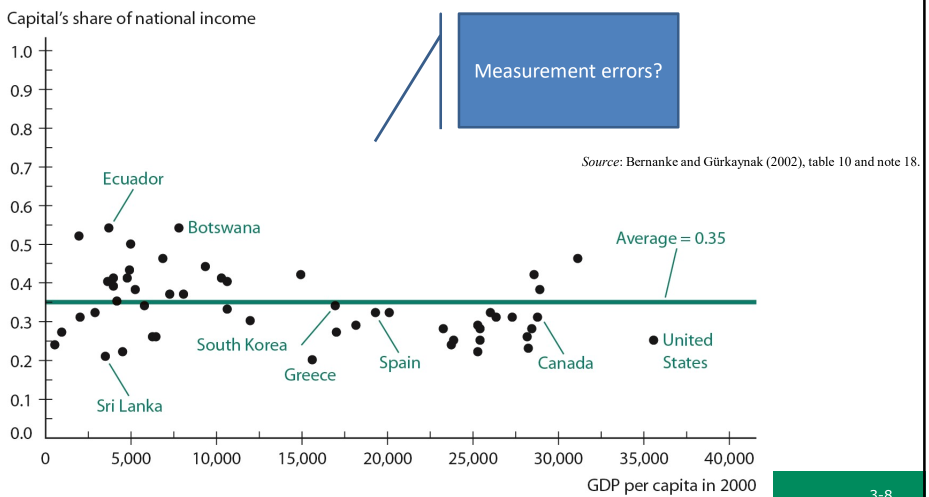
# Capital's Share of Income (which is equal to $\alpha$) in a Cross-Section of Countries

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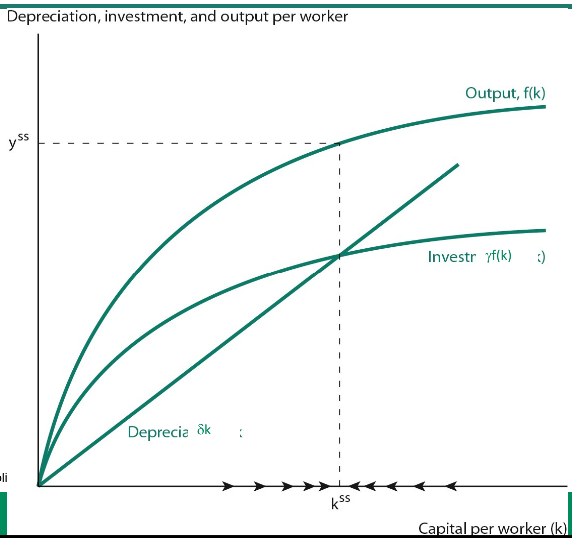
# The Steady State of the Solow Model (with no population dynamics)

γ= saving rate

δ=depreciation rate

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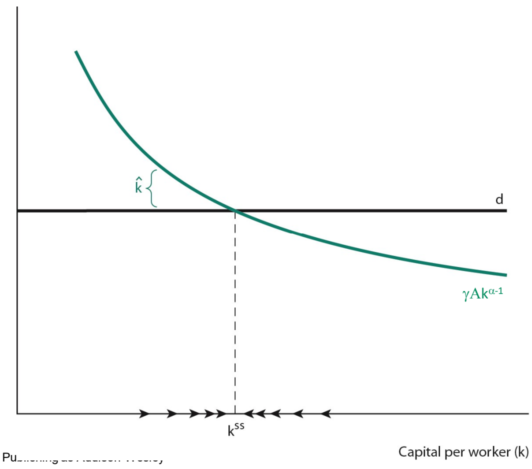
# Speed of Convergence to the Steady State

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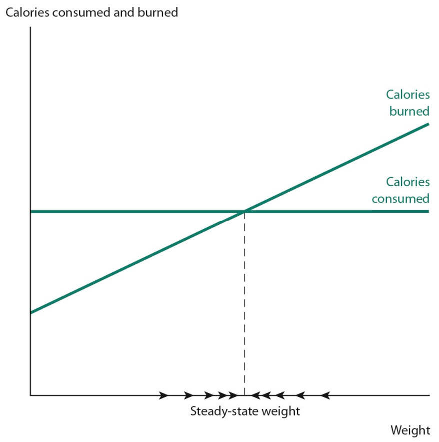
# **A non economic example:** Determination of Steady-State Weight

**Think also about changes in the position of the two lines**

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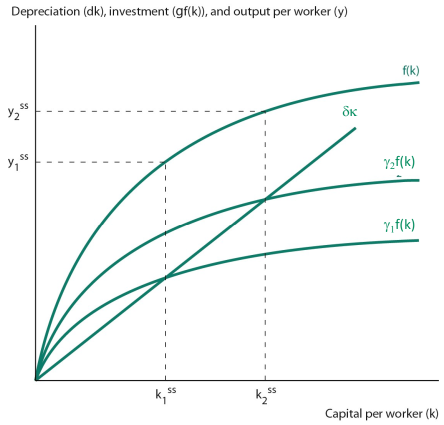
# Effect of Increasing the Investment Rate on the Steady State




Note that $\gamma_2 > \gamma_1$

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# Solow model calibration

Using $y = A\,k^{\alpha}$

- $\Delta k = \gamma\, A\, k^{\alpha} - \delta k$

In steady state $\Delta k$ is equal to zero, that is

- $0 = \gamma\, A\, k_{ss}^{\alpha} - \delta k_{ss}$

Which implies that

- $\gamma\, A\, k_{ss}^{\alpha} = \delta k_{ss} \Rightarrow \gamma\, Ak_{ss}^{\alpha} / k_{ss}\delta = 1 \Rightarrow \gamma\, Ak_{ss}^{\alpha-1}/\delta = 1$
- $k_{ss} = (\delta/\gamma\, A)^{1/(\alpha-1)} = (\gamma\, A/\delta)^{1/(1-\alpha)}$

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# Solow model calibration

- $y_{ss} = A\, k_{ss}^{\alpha} = A^{1/(1-\alpha)} (\gamma/\delta)^{\alpha/(1-\alpha)}$
- If we take the value of y of steady state for country *i* and country *j*, we can compare them in the following way
- $y^{i}_{ss} / y^{j}_{ss} = (\gamma^{i}/\gamma^{j})^{\alpha/(1-\alpha)}$
- Now let us assume that country *i* has an investment rate of 20% and country *j* of 5%

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# Solow model calibration

- With alpha equal to 0.33 the previous formula gives a value of 2….
- … do you remember the example of Silvania and Freedonia?

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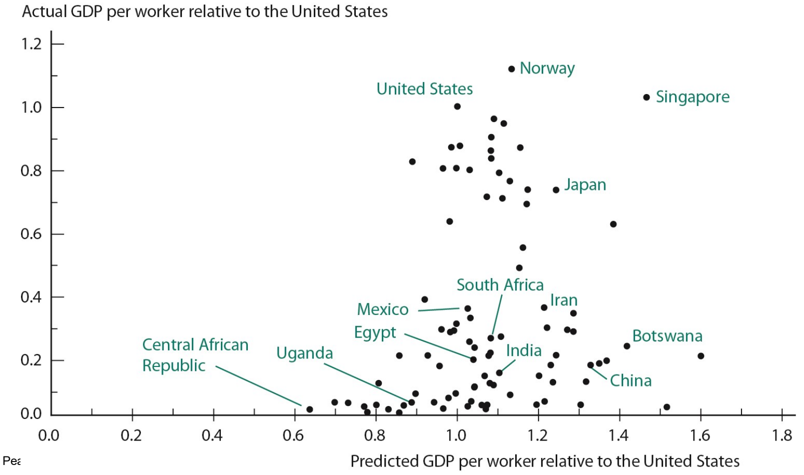
# Predicted versus Actual GDP per Worker

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## The Solow model as a theory of relative growth rates (difference btwn s.r. and l.r.)

The Solow model does not provide a complete explanaton of growth rates since once a country reaches its steady state there is no longer growth!

*Despite this failing we may still ask whether the model has something to say about relative growth rates - that is why some countries grow faster than others…*

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## The Solow model as a theory of relative growth rates (difference btwn s.r. and l.r.)

**The key is to think about countries which are not in s.s.**

- *If two countries have the same rate of investment but different levels of income, the country with lower income will have higher growth*
- *If two countries have the same level of income but different rates of investment, then the country with a higher rate of investment will have higher growth*
- *A country that raises its level of investment will experience an increase in its rate of income growth*

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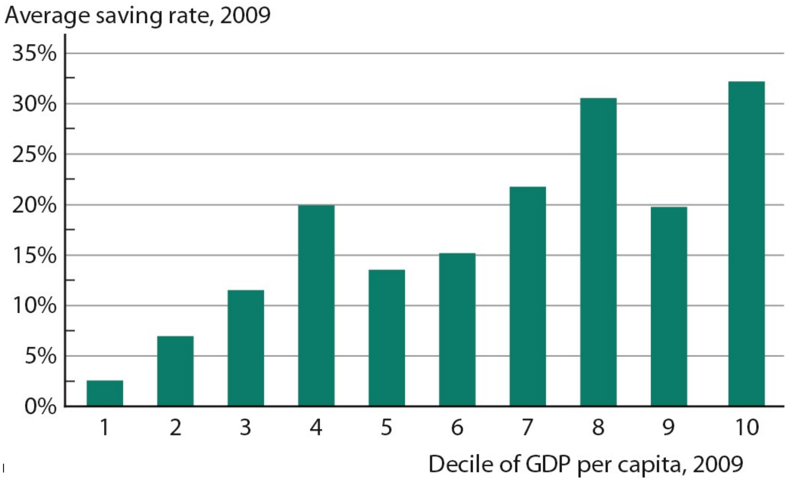
# Saving Rate by Decile of Income per Capita

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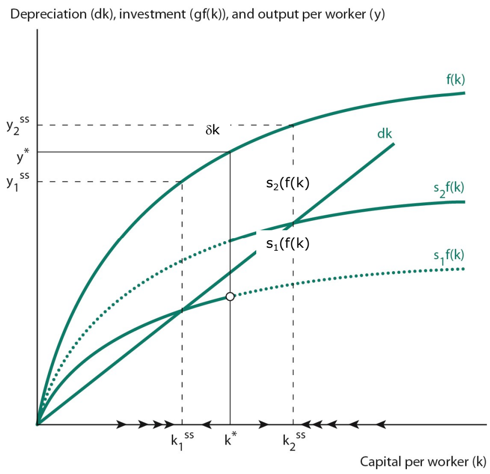
# Solow Model with Saving Dependent on Income Level

**Multiple equilibria=**

**Poverty traps**

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# The rise and fall of capital revisited

- The belief that capital accumulation is the key ingredient for economic growth reached its peak after WWII (see Arthur Lewis and Soviet Union's success)
- Policies were designed accordingly
- Now economist have discarded the idea that development depends mainly on capital accumulation

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