

Long-run growth



Part I The proximate determinants

Keep in mind our approach

- Total income and total output are two sides of the same coin.
- Higher real income is thus equivalent to higher real production.
- Realized production value per worker depends on workers' **ability** to produce valuable goods and services, or **labor productivity**.
- The **proximate** determinants of long-run economic growth explain workers' ability to produce.
- The **fundamental** determinants seek to explain actual differences in the proximate determinants.

Chapter 3

A first proximate determinant:
Physical capital

Proximate determinants: Outlook

- ✓ Role of (physical) capital
- Role of population growth
- Role of human capital
- Role of trade
- Role of productivity
 - Technology
 - Efficiency

Capital Accumulation and Growth

- What is the effect of capital accumulation?
- Can capital accumulation explain income differences between countries?
- If yes, up to what point?
- How is capital being accumulated?

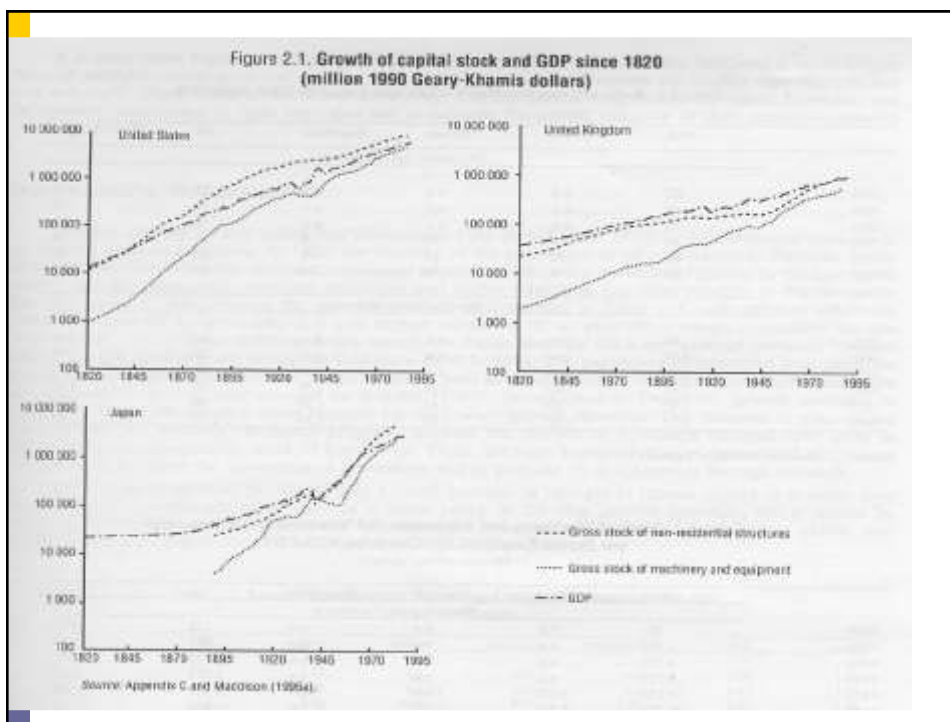
Physical capital: What is it?

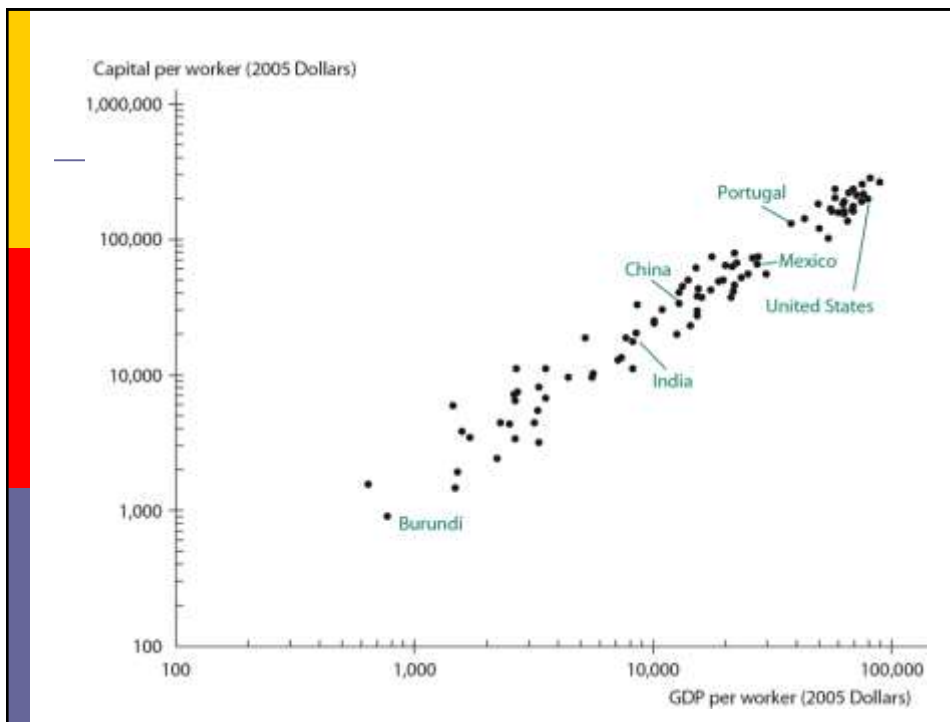
- Machines
- Buildings
- Infrastructure:
 - roads
 - bridges
- Computers
- **Just about any work we do, we do with the help of some type of physical capital. We are more productive this way.**
- NB Not financial capital, land or natural resources.
- In this course, when we say “capital”, we mean “physical capital”.

Capital

Estimated values of capital per worker in 2009:

- USA: \$201,618
- Mexico: \$66,081
- India: \$17,918





Increased importance of capital as wealth

TABLE 3.1
Agricultural Land as a Fraction of
Total Wealth in the United Kingdom

1688	64%
1798	55%
1885	18%
1927	4%
1958	3%

Capital

- Correlation does not imply causality.
- We need a testable theory.
- We will see that capital explains wealth and growth **partly**.
- We will try to **quantify** this part, in order to see what's left to be explained.

Characteristics of physical capital

5 important characteristics:

1. productive
2. produced
3. rival use
4. produces a return
5. wears out

1. Productive

- More capital implies more output.
- Financial capital is not productive per se. Dollars and Bitcoins are not productive.

2. Produced

- Capital is built: Investment
- This is different from natural resources and land.
- Savings rates since 1950 (consumption sacrifice as % of GDP)
 - Canada: 22%
 - Germany: 25%
 - Japan: 34%
- Investment decisions: public and private
- Typical question:
Would increasing the Canadian savings rate lead to sustained higher Canadian growth in the future?

3. Rival (limited) use

- We cannot all use the same tool, bridge, hospital bed, or machine simultaneously.
- In this respect, knowledge (ideas) is fundamentally different.

4. Return

- "Productive" implies a return to its owner.
- Since capital increases a worker's productivity, he is willing to pay for it:
 - Machine rental
 - Building rental
 - Profits on new paper mill to be paid to shareholders.
- That is why people build capital.
- The state also builds capital: roads, airports, schools, hospitals,...

5. Depreciation

- Capital wears out:
 - rust
 - bad weather
 - material's fatigue
- A good part of our investments seek to make up for worn out capital. It does not increase the available stock.

Capital's role in production

- But how exactly is capital productive?
- We need a theory.

Capital

A theory linking capital levels
with output levels

Capital's role in production

A theory begins with assumptions:

1. 2 inputs: K and L
 2. Constant returns to scale (CRS)
 3. The marginal product of capital (MPK) is decreasing:
 - MPK: Increase in output due to one additional unit of capital
 - Decreasing MPK: The higher the pre-existing amount of capital per worker, the lower is MPK.
 - *Decreasing Returns to Capital*
 - Be careful to differentiate **returns to a factor** from **returns to scale**.
- **(take note)**

Specific Production Function

- More specific *Cobb-Douglas* functional form is often used because it “performs well” with the data and is mathematically easy to work with.
- **(take note)**
- Parameter α : How K and L are combined to produce Y.
- *Verify by yourself that the function is CRS and the MPK is decreasing.*

Factor payments and factor proportions

- It would be great if we could estimate parameter α in a given economy.
- To this end, it suffices to estimate the share of revenues from capital in the economy. Here’s why: **(take note)**

Recall micro 101

- In a competitive economy, in equilibrium, factors are paid their marginal product.
- The salary of a worker is equal to its marginal product. Can you explain why?
- Analogously, the rental cost of capital is equal to its marginal product.

Capital's rental cost

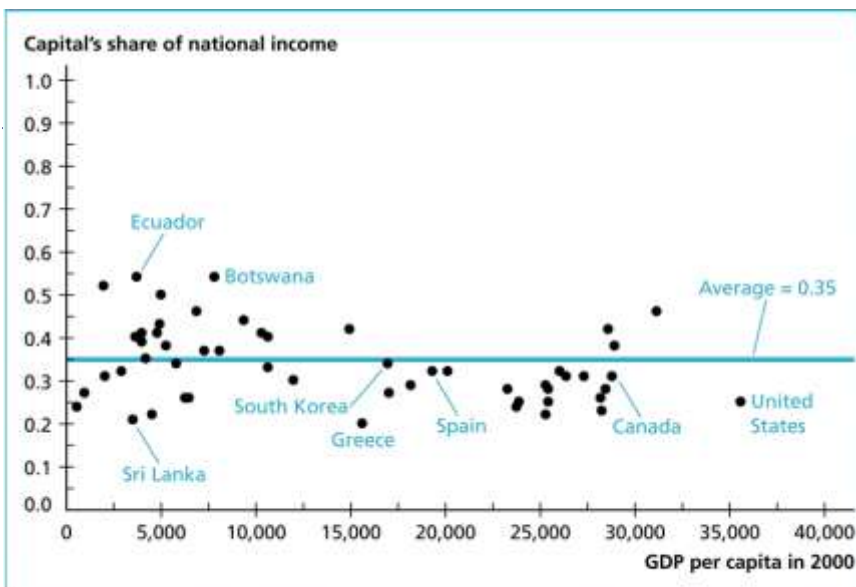
- Corresponds to the payment per unit of capital that its owners receive. This is called the return to capital.
 - an apartment's rent
 - a firm's profits
 - a truck's rental income
 - a stock's dividends
- NB If capital did not produce a return, (almost) no-one would privately invest in it. It would not be built.

Useful result

We can estimate α simply by measuring the share of capital in national income!

- We generally obtain:

$$\alpha \approx 1/3$$



Source: Bernanke and Gürkaynak (2002), table 10 and note 18.

Predicting the amount of capital

- We developed a theory that links per capita output to quantity of capital per worker.
- But how can we explain the existing stock of capital?
- Proposition: **Solow model**

The Solow Model

Predicting the quantity of
capital in an economy

Determination of capital per worker

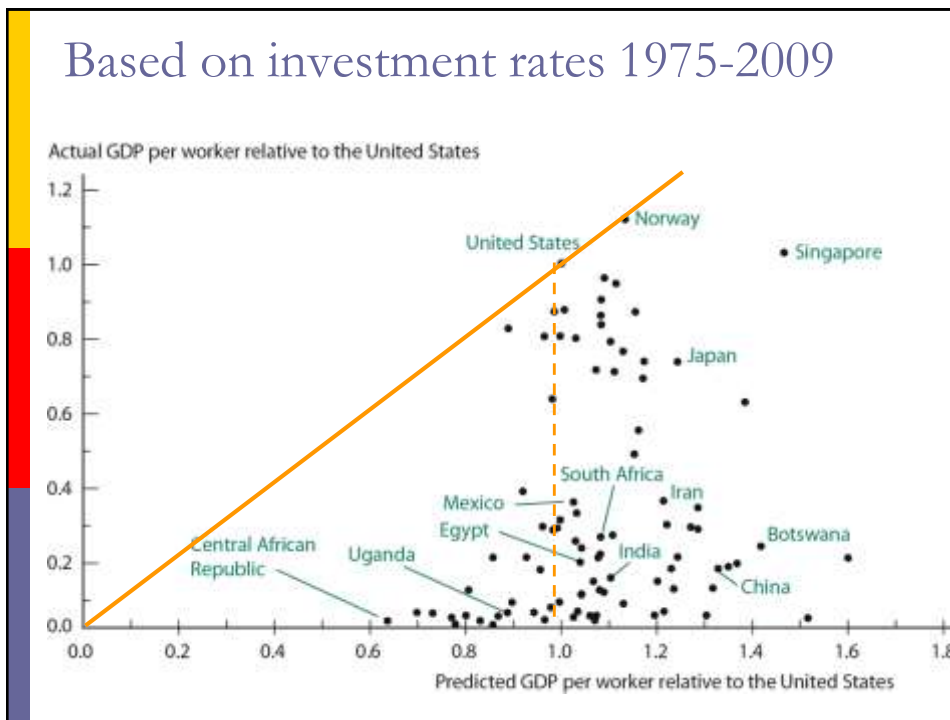
- Simplifying assumptions for now:
 - Constant worker population: L
 - Unchanging production function: No technological progress
 - Remark: The simplifications seek to help us understand the specific role of capital.

(take note)

Testing the theory

- We assume a Cobb-Douglas national production function.
- Those results have been applied to many countries to see how the Solow model can explain differences of income levels between countries.

Based on investment rates 1975-2009



Interpretation of graph:

- If the Solow model were a perfect predictor, all the points would fall on the 45% line.
- If the model were a completely useless predictor, there would be no correlation.
- Here, it seems to predict partly: Countries with low investment rates tend to have lower income levels and conversely.
- Correlation is 0.17 (and 0.35 using logs).
- Income per capita in CAR is predicted to be 63% that of the USA. In reality, it is just 1.9%.
- The USA's actual income level is much higher than predicted by the model. (The USA is the benchmark country and all others are below the 45% line.)
- The model predicts that about half of the countries in the sample should be richer than the USA. Only Norway and Singapore are.

Previous edition (interestingly)



Sources: Calculations based on Heston et al. (2006) and World Bank (2007a).

Previous edition

- 2nd ed: "Fig 3.7 shows a significant relationship between predicted income and actual income." (Weil p65)
- 3rd ed: "Fig 3.7 shows that there is some relationship between predicted income and actual income, but not a strong one." (Weil p 64)

Other explanations to consider

1. There must be other factors that affect income levels:
 - population growth
 - other production factors
 - productivity differences
 - Technology
 - Efficiency
2. Countries may not be in a steady-state
 - war that destroys capital
 - changes in the investment rate
 - **More on all of the above coming soon.**

Implications of Alternative Saving Rates

What are the effects of the savings rate on the rate of output per worker?

1. The savings rate has no effect on the long run growth rate of output/worker. (It is equal to zero in the present model.)
2. The savings rate determines the level of output/worker in the long run.
3. An increase in the savings rate leads to a higher growth of output/worker for some time, but not forever.

Explaining growth rate differences

- With the help of the Solow model, we have studied the role of capital in explaining income level differences.
- Can the Solow model also explain observed growth rate differences between countries?

The Solow model and growth rates

1. Does not provide a full explanation.
2. Pretty good at explaining relative growth rates.
3. **Transition growth:** When the amount of capital is below its steady-state value.
4. **Convergence:** When the stock of capital tends towards the steady-state level corresponding to its savings rate.

According to Solow's model

The farther a country is from its steady-state, the larger its growth rate.

(take note)

Predictions

1. If two countries have the same investment rate but different income levels, the one with the lowest income level will grow fastest for some time.
2. If two countries have the same income level but different investment rates, the one with the highest investment rate will grow faster for some time.
3. If the investment rate increases, the growth rate increases also for some time.

Major implications of the Solow model

1. The long-run growth rate is zero. Hence, the model cannot explain LR differences in growth rates.
2. The short-run growth rate is higher the farther k is from its SS value. (due to DRK)
3. Larger investment rate implies larger SS income level.

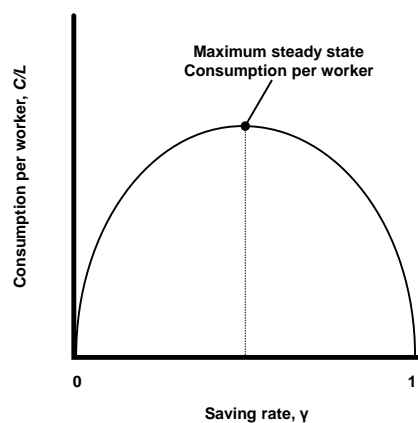
Other implications of the Solow model

1. The Golden Rule
2. Capital and the history of economic thought on development policies
3. Explaining the savings rate
4. The development trap theory
5. Development aid

A word on savings and consumption

- **The Golden-Rule Level of Capital:** The value of savings that yields the highest level of consumption in steady state.
- **(take note)**

The Golden Rule level of capital



A little history of economic thought

Part 1: The rise of Capital

- For the classical economists (Ricardo 1772-1823, Malthus 1766-1834), land is the most important factor.
- In the 40s-50s (Lewis, Rostow), capital accumulation is the key to economic development.
 - Experience USSR: very large national savings rate accompanied by initial large growth rate
- Implications for LDC's 50s to 70s:
 - Main objective: Raise stock of capital through higher investments.
 - Concentration of efforts (eviction effect).
 - Development aid seeks mainly to increase capital stocks of developing countries.

A little history of economic thought

Part 2: The fall of Capital

- This large concentration of efforts on physical capital is now seen as a failure.
- Physical capital, though an important factor that cannot be neglected, does not occupy today the central role that it used to.

Capital's downfall

Other elements to account for:

- education (especially the girls)
- productivity (technology and efficiency)
- institutions (democracy, justice, property rights, law of contracts, ...)
- International Trade
- Women empowerment (In July 2010, the United Nations General Assembly created **UN Women**, the United Nations Entity for Gender Equality and the Empowerment of Women.)
- ...

To recap

We have proposed a theory to understand:

- How capital can explain income levels.
- How investments rates can explain capital stocks.
- How investments rates can explain growth rates.

But can we explain differences in investment rates?

Explaining investments rates

- To any investment decision corresponds a decision to save.
- Is it just the people's savings rate then?

Complication: foreign investment

- Investment crosses frontiers: A Canadian citizen's savings can be used to build capital in Nicaragua.
- International capital flows can break the link between savings and investment. (later chapter on openness)
- Observations indicate that this link is nevertheless quite relevant.
- We will adopt this last view for now.

Explaining the saving rates

Variables that are *exogenous* to the Solow model:

- Government policies
- Culture (Is it just that some people are more spend thrift than others?)
- Protection of property rights (Institutions in general)

Some of those are “fundamental” factors that we would like to consider eventually.

Government policies

Governments often adopt policies aimed at increasing the savings rate in order to increase investment rates:

1. With budget surpluses or public debt (though the latter can evict partly private investment).
2. By type of mandatory pension plans:
 - If *pay-as-you-go*: lower savings
 - If by investment funds: higher savings

Government policies

Examples of forced savings abound:

- Canada Pension Plan (CPP): Part of the workers' contributions are invested in private sector financial instruments - bonds, stocks, real estate - by the CPP Investment Board.
- Equivalent in Québec: RRQ and Caisse de dépôt et placement du Québec.
- Chile: Private savings increased from 0% in early 1980s to 17% in 1991 through forced funded plans.
- Singapore: 40% of salaries in early 1980s.

Government policies

“Propaganda” in Japan:

- Numerous publicity campaigns during 20th c. aimed at encouraging savings.
- Education programs on importance of savings.
- Japan had one of the highest savings rate in the world after WWII.

Explaining the saving rates

Endogenous saving rates (part 1):

- Maybe it is just that richer countries save more but that savings does not make them richer.
- This is the problem of the **missing variable**.
- It would mean that savings and capital accumulation are not important to explain economic growth. It would invalidate the Solow model completely.
- Empirical work does not support that view.

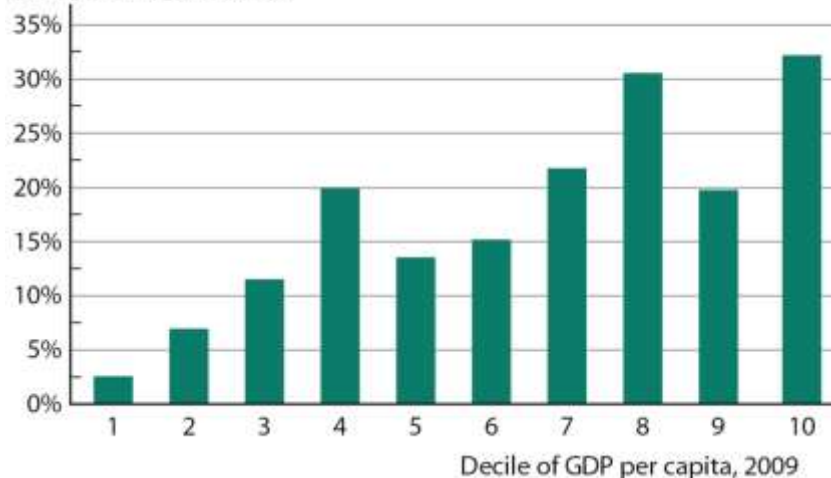
Explaining the saving rates

Endogenous saving rates (part 2):

- Savings makes people richer but remains endogenous.
- If true, this may have extremely important implications.
- Let us adopt the view that the poorer we are, the lower our savings rate is.

Endogenous saving rate

Average saving rate, 2009



Theory of the *Development trap*

- **(take note)**
- A country is poor because its savings rate is low.
- The savings rate is low because the country is poor.
- Countries are identical otherwise.
- The stationary state depends solely on initial conditions, i.e. initial stock of capital.
- Existence of multiple stationary states.

Theory of the *Development trap*

- Result with very dramatic consequences.
- Countries do not differ fundamentally.
- This result is subject to much controversy.
- What makes it especially controversial is that it carries important policy implications as far as development aid is concerned. Let us see why.

The Millennium Development Goals (MDG)

UN 2000

Make substantial progress towards eradication of poverty and other human development goals by 2015.

Eight initial goals:

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/Aids
7. Ensure environmental sustainability
8. Develop a global partnership for development

The Millennium Development Goals (MDG)

Be careful not to confuse objectives with means.

- Objectives are laudable.
- The means are subject to much controversy.

The means to achieve the MDG

**Much emphasis on
doubling development aid.**

- Problem: Empirical evidence suggests that past development aid efforts are globally not effective
- *Development trap* argument: Past inefficiency of development aid is due to its low level. (Economist Jeffrey Sachs)
- Development aid must jump above a certain threshold in order to be effective.

The means to achieve the MDG

Opposition:

- Many are not convinced by the development trap argument. (There is in fact no convincing empirical confirmation.)
- Some recent empirical evidence suggests that development aid becomes effective if combined with **governance indicators**.

Governance Indicators (The fundamentals)

- Democracy (politicians are accountable)
- Corruption
- Respect for property rights
- Rule of Law
- Justice
- Freedom of press
- ...

Is there a solution?

Conditionality of Aid

- **Problem:** Interference with internal affairs of independent countries.
 - "From the start, the commission faced two major challenges. First, President René Préval did not really support it, seeing it as a usurpation of power, several former commission members said." (NYT 2012)
- What else can we do?
- NB Sachs' prescriptions are no less conditional. They indicate precisely and with great detail where to spend aid money. Is this easier to implement in LDCs because it does not alter the structure of their institutions, i.e. distribution of power?
- More research is required.

Conclusions

Physical capital

The basics

1. We have defined physical capital and listed its intrinsic characteristics relevant to explain growth.
2. We have compared per-capita stocks of capital across countries and through time.

Conclusions

The Solow model helps us locate the role played by capital accumulation in the process of economic growth.

1. Physical capital is responsible for about 1/3 of income levels.
2. For a given savings rate, a country converges towards a long-run steady-state.
3. The long-run income growth rate is zero in the basic Solow model.
4. The farther a country is from its steady-state, the faster its growth rate. Convergence or catch-up phase
5. A higher savings rate increases long run income level but not growth rate. It is impossible to sustain long-run economic growth simply with higher saving.
6. Possibility of development traps.

Conclusions

An unfinished job.

- There is still a lot left to explain, i.e.
 1. Balance of unexplained income levels
 2. Long-run growth
 3. Economic decline and divergence

Conclusion

- ✓ Role of capital
- Role of population growth (next)
- Role of other production factors
- Role of world trade
- Role of productivity
 - Technology
 - Efficiency

Conclusions

We will essentially add bricks to the Solow model in order to build an edifice called **Understanding Economic Growth.**

FIGURE 3.10
Speed of Convergence to the Steady State

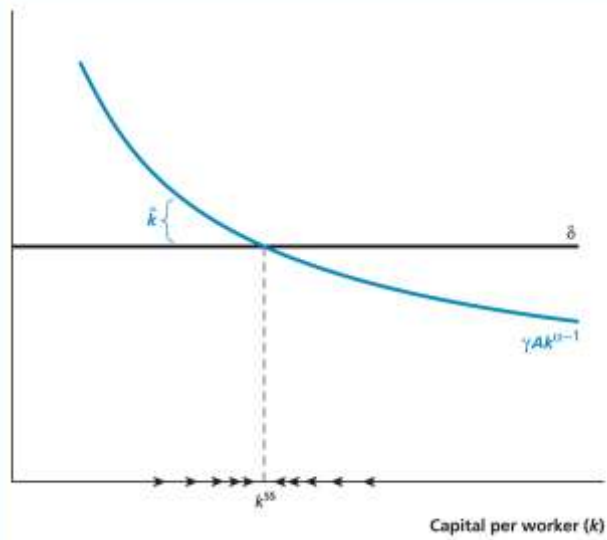


FIGURE 3.9
Solow Model with Saving Dependent on Income Level

Depreciation (δk), investment ($\gamma f(k)$), and output per worker (y)

