Economic Growth: Solow Growth Model

ECO 305: Intermediate Macroeconomics

Goals

Use Solow growth model theory to explain...

1. Why some countries have high rates of growth and other have low rates of growth
2. What factors affect economic development and growth
3. Shortcomings of the theory

Reading and Exercises

- Williamson, Chapter 7, pp. 249-255: Solow Model
- Williamson, Chapter 7, pp. 255-264: Long-run effects from changes to savings, technology, depreciation, and population growth
- **Canvas Quiz due Wednesday 11:59 PM**. Multiple-choice, 10 questions, unlimited attempts allowed, only best score counts
- **Homework/Exercise due Friday 11:59 PM**. We will work together in class on Thursday

Reading and Exercises

- Williamson, Chapter 7, pp. 249-255: Solow Model
- Williamson, Chapter 7, pp. 255-264: Long-run effects from changes to savings, technology, depreciation, and population growth
- **Canvas Quiz due Wednesday 11:59 PM**. Multiple-choice, 10 questions, unlimited attempts allowed, only best score counts
- **Homework/Exercise due Friday 11:59 PM**. We will work together in class on Thursday

Reading and Exercises

- Williamson, Chapter 7, pp. 249-255: Solow Model
- Williamson, Chapter 7, pp. 255-264: Long-run effects from changes to savings, technology, depreciation, and population growth
- **Canvas Quiz due Wednesday 11:59 PM**. Multiple-choice, 10 questions, unlimited attempts allowed, only best score counts
- **Homework/Exercise due Friday 11:59 PM**. We will work together in class on Thursday

Reading and Exercises

- Williamson, Chapter 7, pp. 249-255: Solow Model
- Williamson, Chapter 7, pp. 255-264: Long-run effects from changes to savings, technology, depreciation, and population growth
- **Canvas Quiz due Wednesday 11:59 PM**. Multiple-choice, 10 questions, unlimited attempts allowed, only best score counts
- **Homework/Exercise due Friday 11:59 PM**. We will work together in class on Thursday

Economic Growth Facts Over Time

- Before the industrial revolution in about 1800, standards of living did not grow much over time.
- Since the industrial revolution, per-capita income growth has grown slowly and steadily in the richest countries
  - The average growth rate of per-capita income in the richest countries is about 1-3%.

Economic Growth Facts Over Time

- Before the industrial revolution in about 1800, standards of living did not grow much over time.
- Since the industrial revolution, per-capita income growth has grown slowly and steadily in the richest countries
  - The average growth rate of per-capita income in the richest countries is about 1-3%.

Economic Growth Facts Over Time

- Before the industrial revolution in about 1800, standards of living did not grow much over time.
- Since the industrial revolution, per-capita income growth has grown slowly and steadily in the richest countries
  - The average growth rate of per-capita income in the richest countries is about 1-3%.

Economic Growth Facts Across Countries

- Before the industrial revolution, standards of living were similar across much of the world.
- Differences in per-capita income across countries have grown significantly since the industrial revolution.
- Rich countries today are similar in terms of per-capita income growth.
- Lesser-developed countries today are less alike in terms of per-capita income growth.

Economic Growth Facts Across Countries

- Before the industrial revolution, standards of living were similar across much of the world.
- Differences in per-capita income across countries have grown significantly since the industrial revolution.
- Rich countries today are similar in terms of per-capita income growth.
- Lesser-developed countries today are less alike in terms of per-capita income growth.

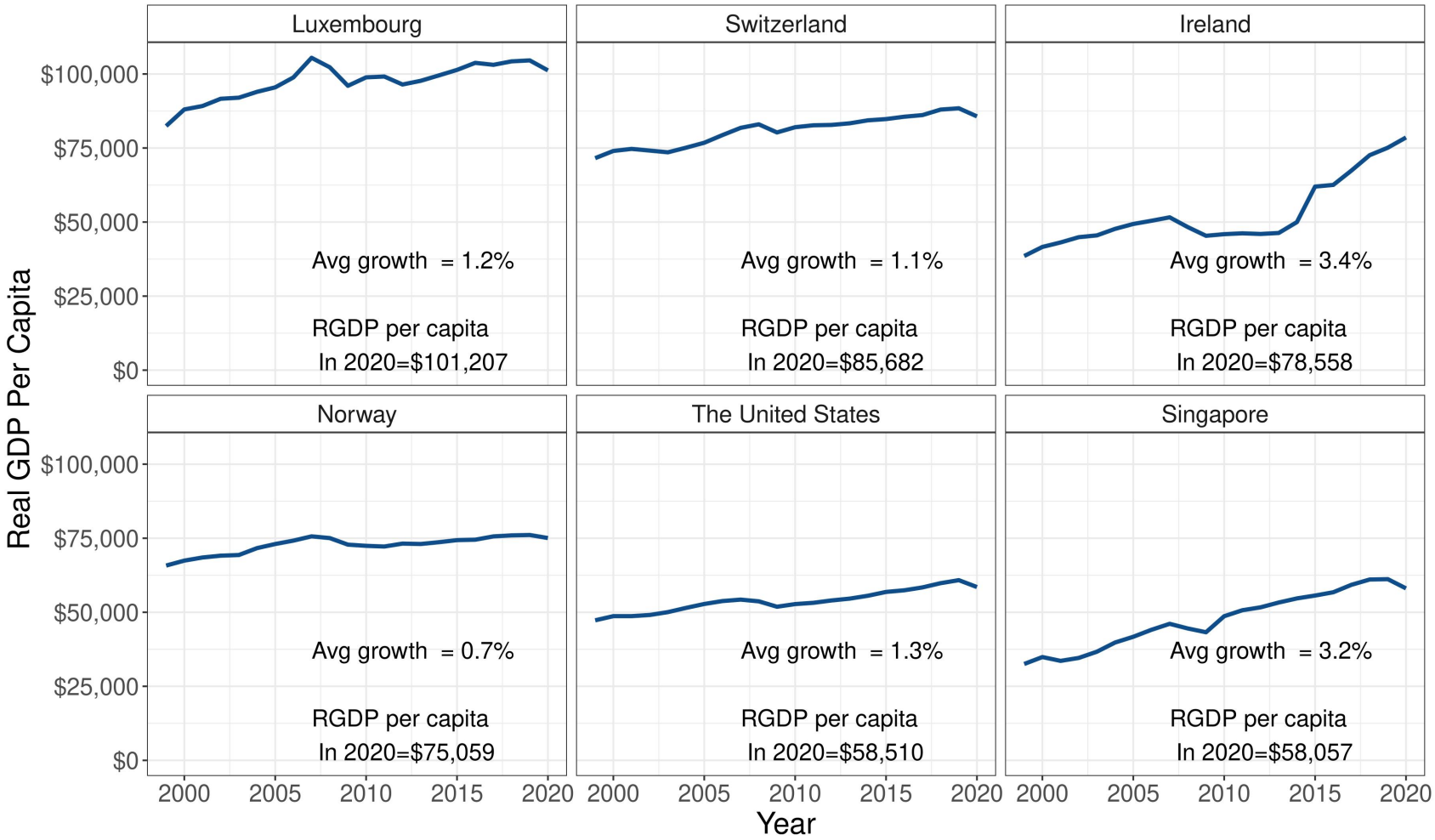
Economic Growth Facts Across Countries

- Before the industrial revolution, standards of living were similar across much of the world.
- Differences in per-capita income across countries have grown significantly since the industrial revolution.
- Rich countries today are similar in terms of per-capita income growth.
- Lesser-developed countries today are less alike in terms of per-capita income growth.

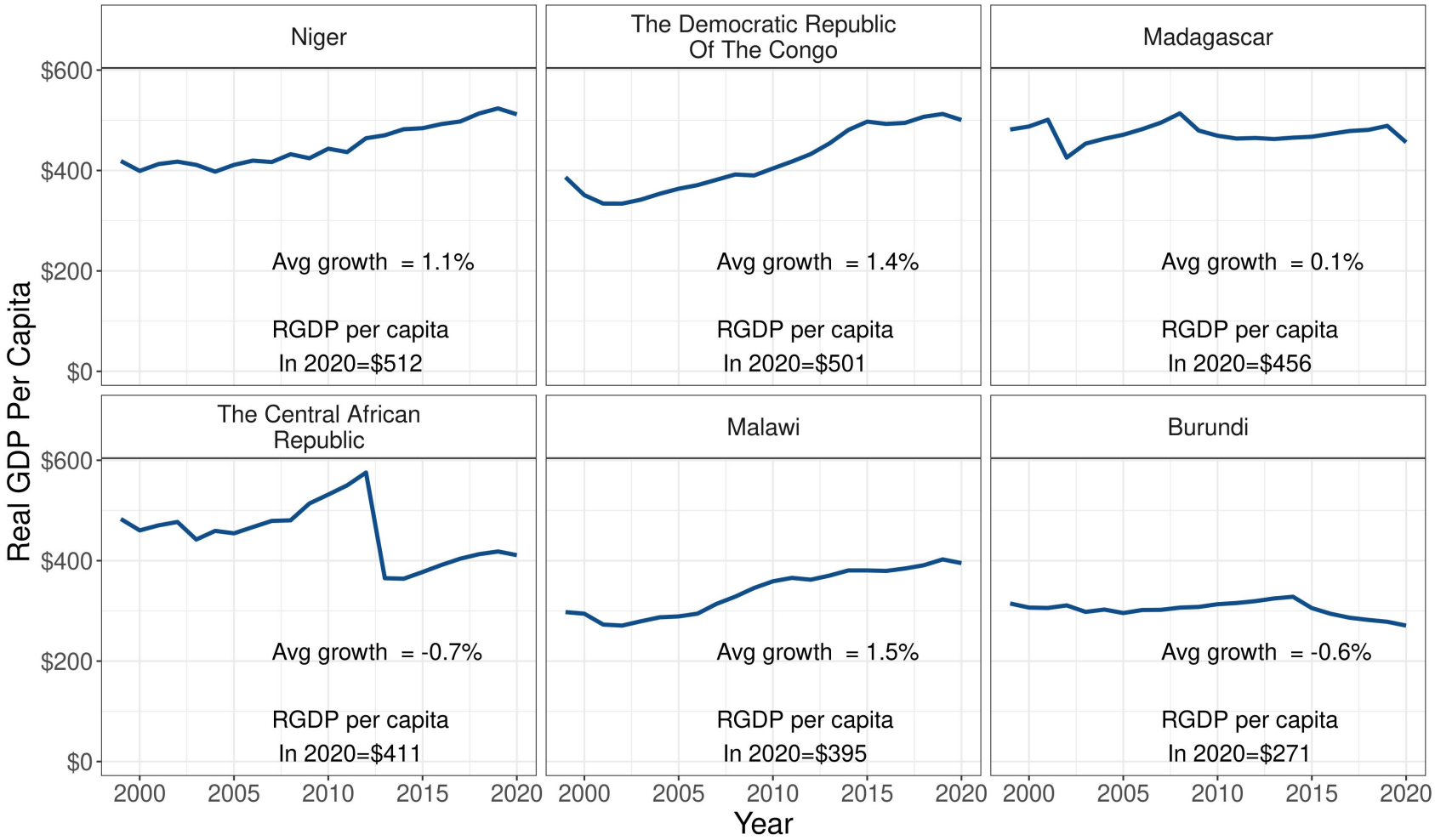
Economic Growth Facts Across Countries

- Before the industrial revolution, standards of living were similar across much of the world.
- Differences in per-capita income across countries have grown significantly since the industrial revolution.
- Rich countries today are similar in terms of per-capita income growth.
- Lesser-developed countries today are less alike in terms of per-capita income growth.

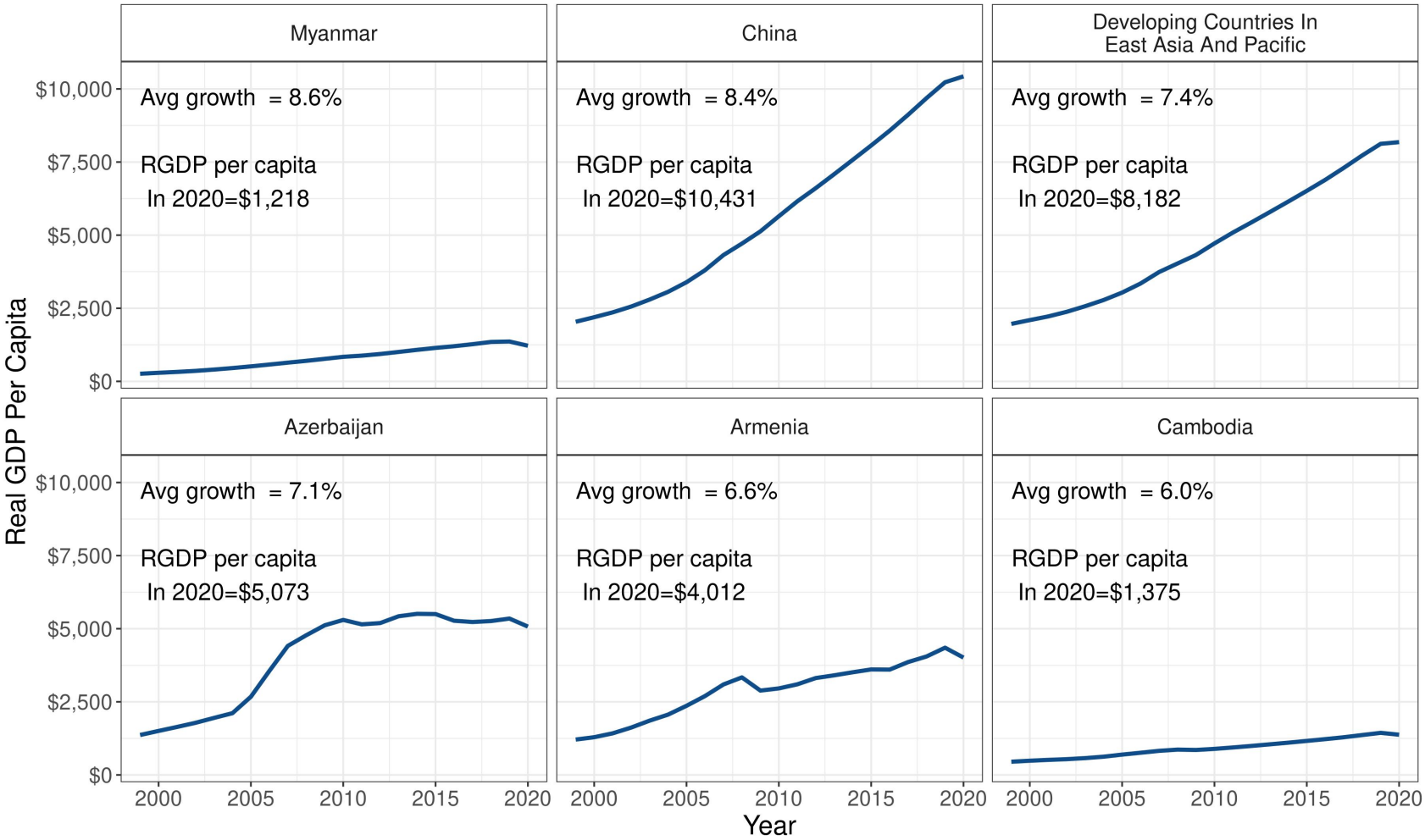
Richest Economies (Real GDP Per Capita in 2020)



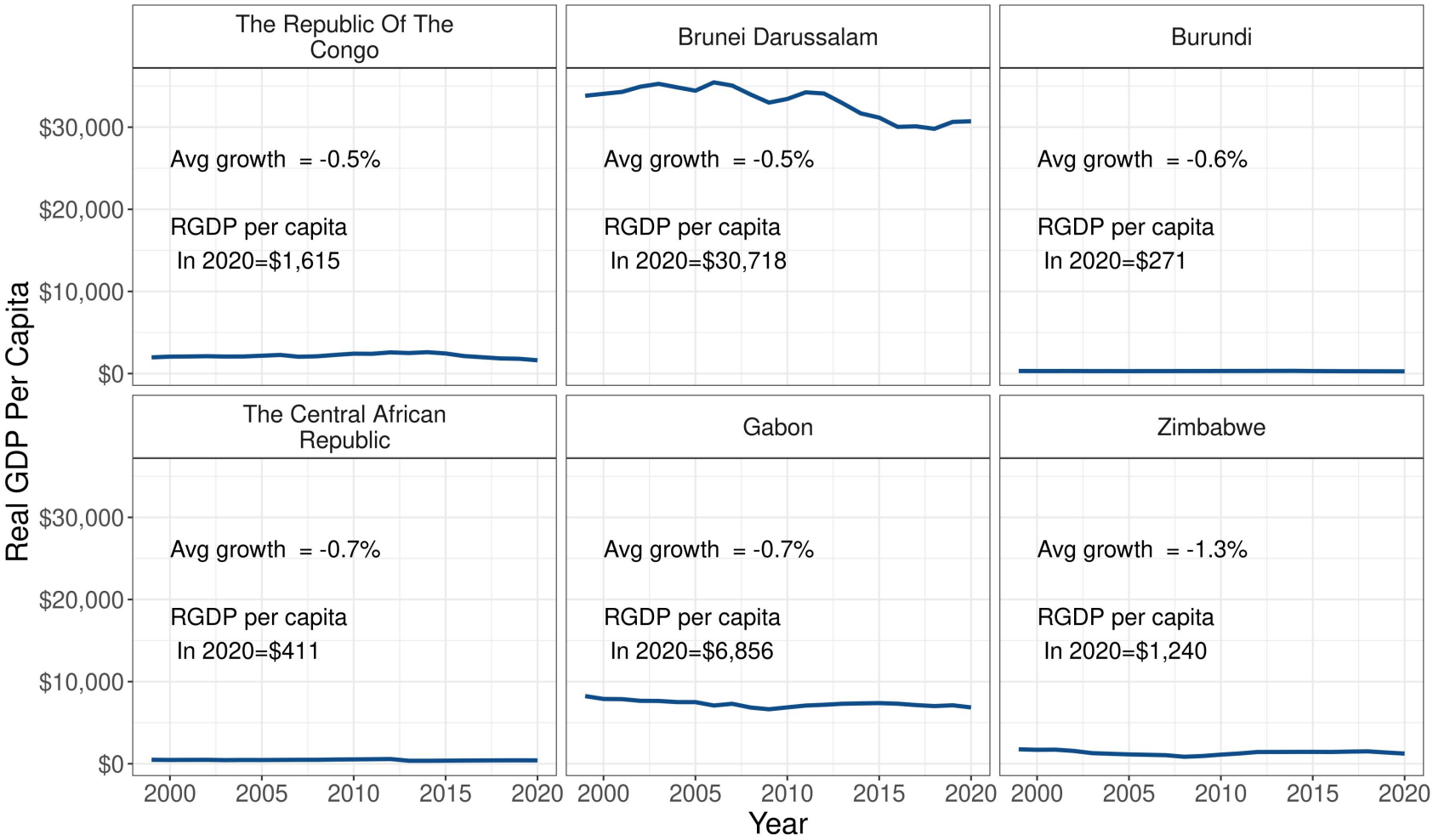
Poorest Economies (Real GDP Per Capita in 2020)



Fastest Growing Economies (1999-2019)



Slowest Growing Economies (1999-2019)



Growth Covariates

- There is a negative relationship between population growth rates and per-capita income growth rates.
- There is a positive relationship between investment rate (as a percentage of real GDP) and per-capita income for **lesser developed countries**.
- There is a negative relationship between investment rate and per-capita income for **more developed countries**.

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Foundations of Solow Growth Model

Consumer Behavior

- Private consumer savings: $S = sY$
- Population growth: $N' = (1 + n)N$
- $s \in (0, 1)$: exogenous savings rate
- $n \in (0, 1)$: exogenous population growth rate

Government Behavior

- Government budget: $G = T + B$
- Government borrowing: $B = bY$
- $b \in (0, 1)$ is exogenous rate of government borrowing
- Let $s_N = s - b$, $s_N \in (0, 1)$ denote national savings rate

Investment and Capital

- Evolution of Capital Stock: $K' = (1 - d)K + I$
- K and K': capital today / future
- I: real quantity of investment
- $d \in (0, 1)$: exogenous depreciation rate

Production Function

- Production function: $Y = zf(K, N)$
- Per-worker production function: $y = zf(k)$
- y is output/worker (real GDP per capita)
- k is existing quantity of capital stock per worker

Further Assumptions

- Diminishing marginal of capital
- Constant returns to scale: When an economy increases all of its factors of production (i.e. both labor and capital) by the same percentage, production goes up by the same percentage

Further Assumptions

- Diminishing marginal of capital
- Constant returns to scale: When an economy increases all of its factors of production (i.e. both labor and capital) by the same percentage, production goes up by the same percentage

Results of the Solow Growth Model

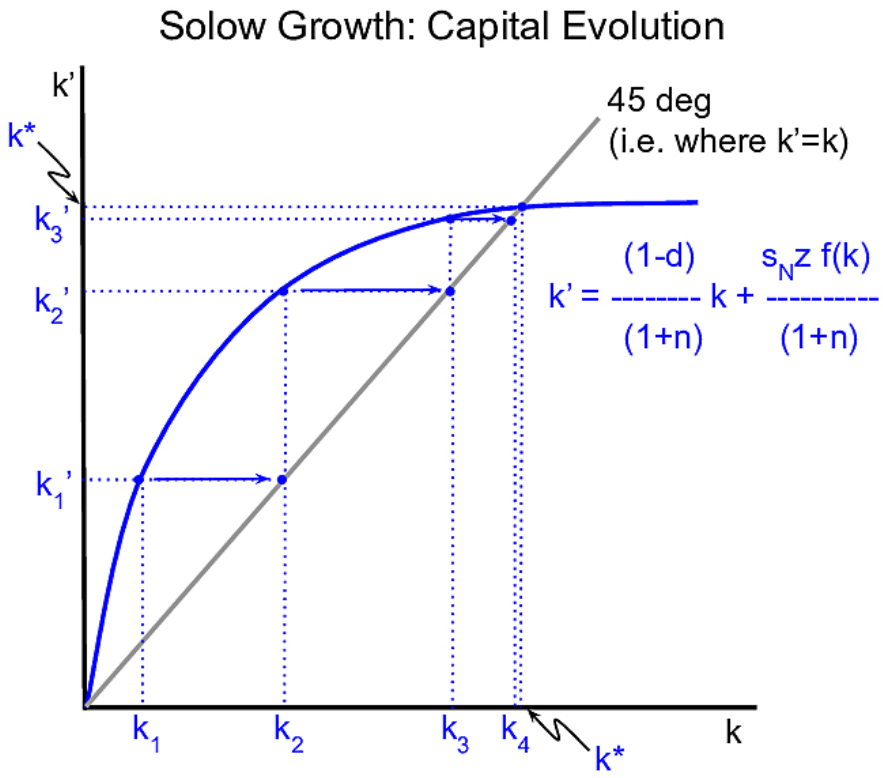
Conclusions

Evolution of capital stock per worker:

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

Savings and Investment:

- $I = S - B$
- $I = sY - bY = (s-b)Y = s_N Y$
- Investment = National Savings



Results of the Solow Growth Model

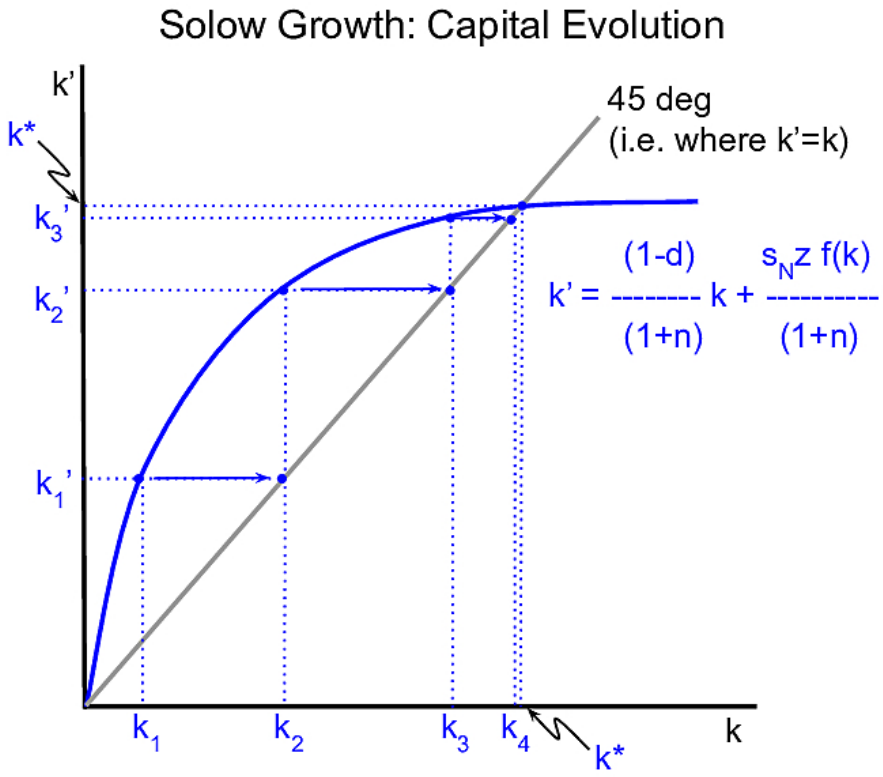
Conclusions

Evolution of capital stock per worker:

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

Savings and Investment:

- $I = S - B$
- $I = sY - bY = (s-b)Y = s_N Y$
- Investment = National Savings



Results of the Solow Growth Model

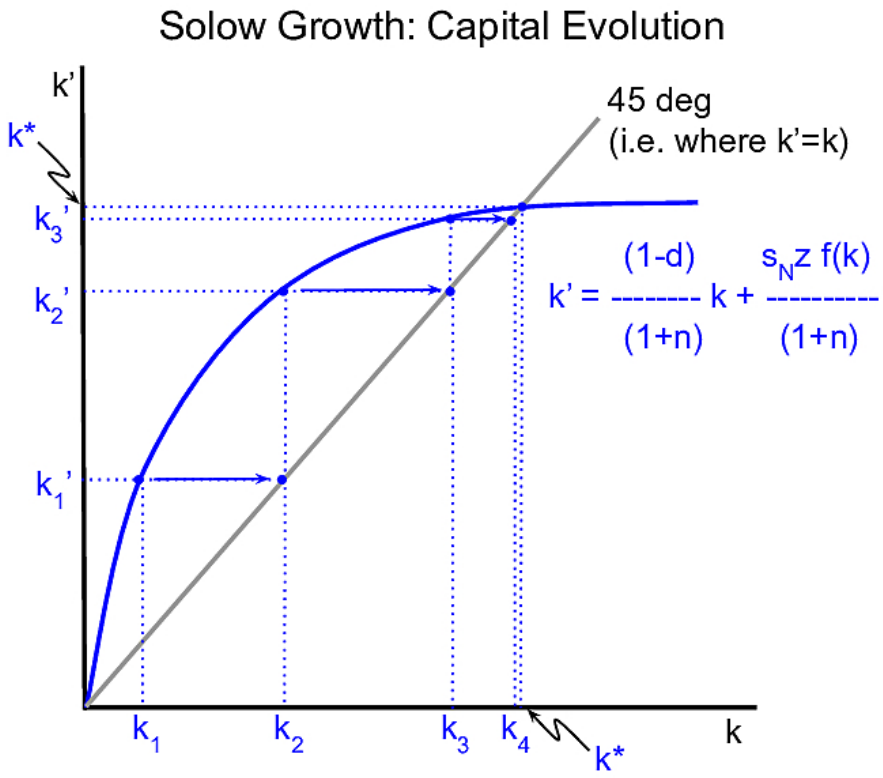
Conclusions

Evolution of capital stock per worker:

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

Savings and Investment:

- $I = S - B$
- $I = sY - bY = (s-b)Y = s_N Y$
- Investment = National Savings



Results of the Solow Growth Model

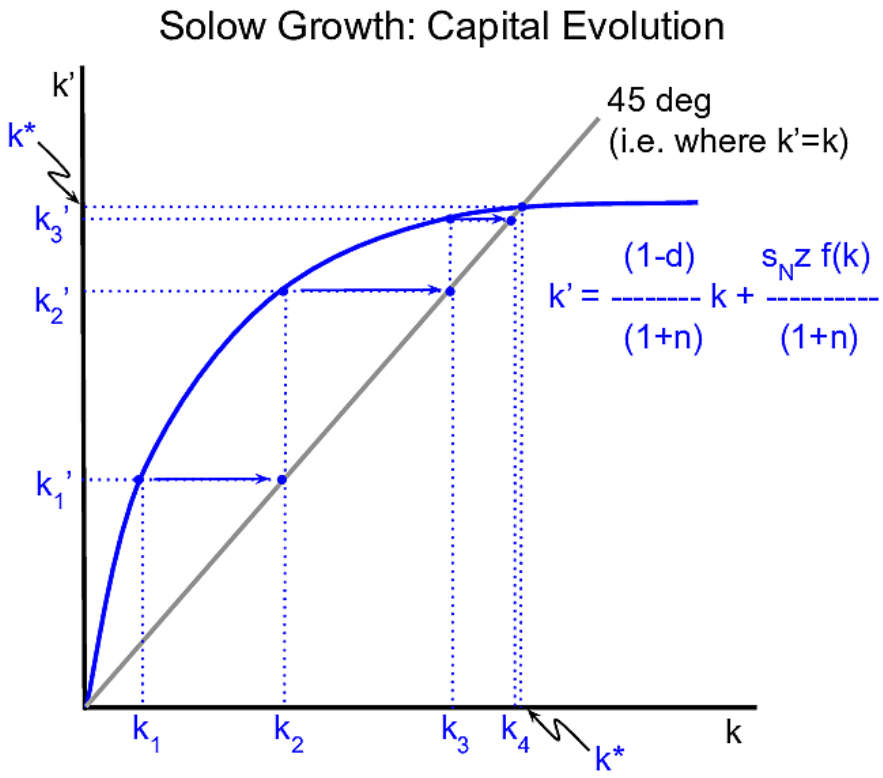
Conclusions

Evolution of capital stock per worker:

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

Savings and Investment:

- $I = S - B$
- $I = sY - bY = (s-b)Y = s_N Y$
- Investment = National Savings



Results of the Solow Growth Model

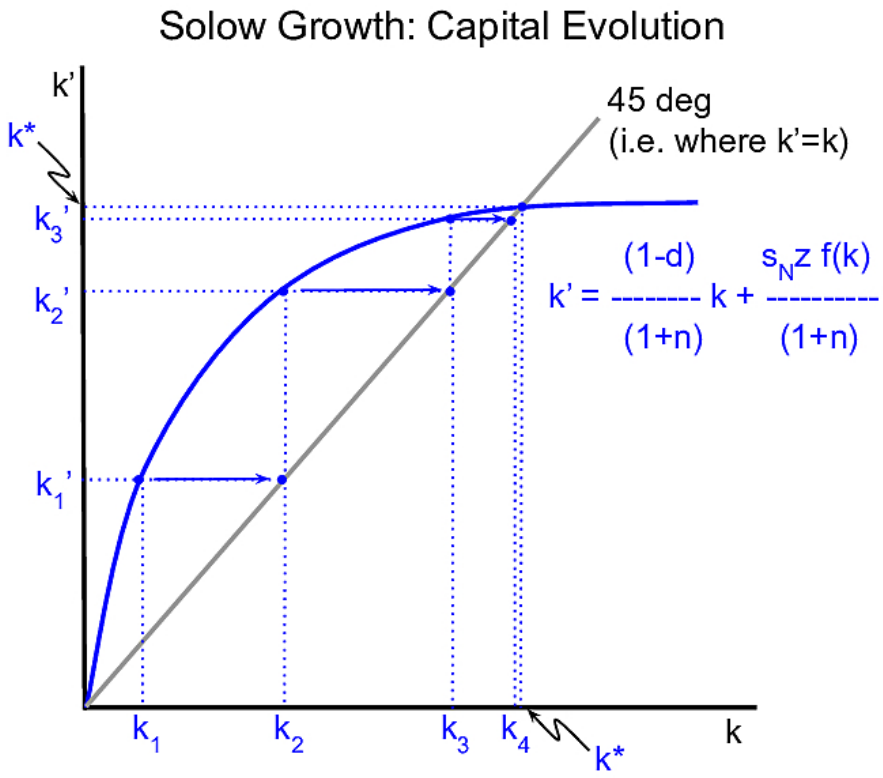
Conclusions

Evolution of capital stock per worker:

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

Savings and Investment:

- $I = S - B$
- $I = sY - bY = (s-b)Y = s_N Y$
- Investment = National Savings



Results of the Solow Growth Model

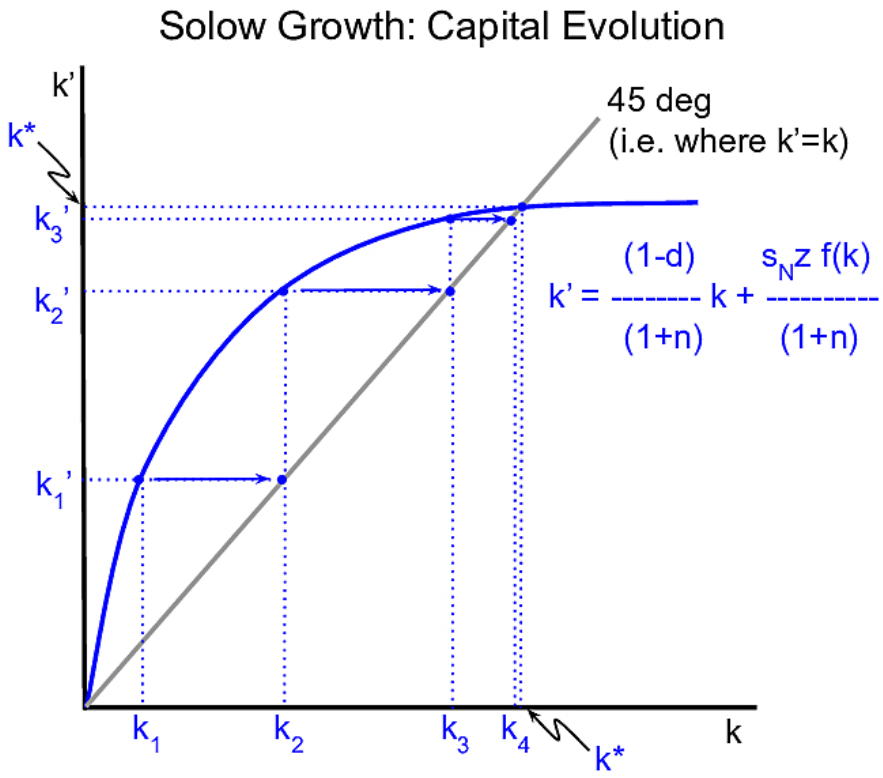
Conclusions

Evolution of capital stock per worker:

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

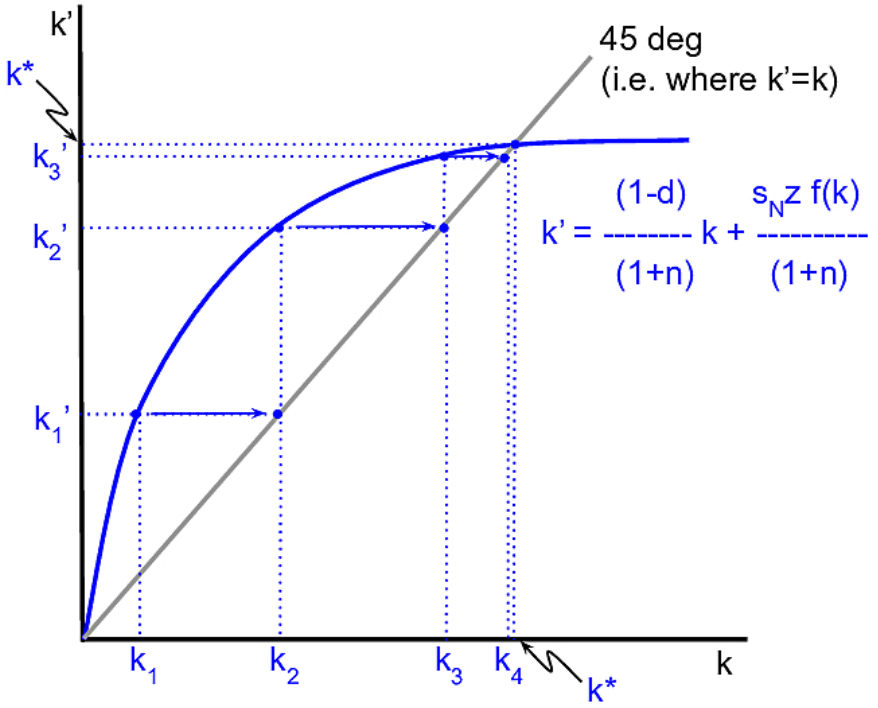
Savings and Investment:

- $I = S - B$
- $I = sY - bY = (s-b)Y = s_N Y$
- Investment = National Savings

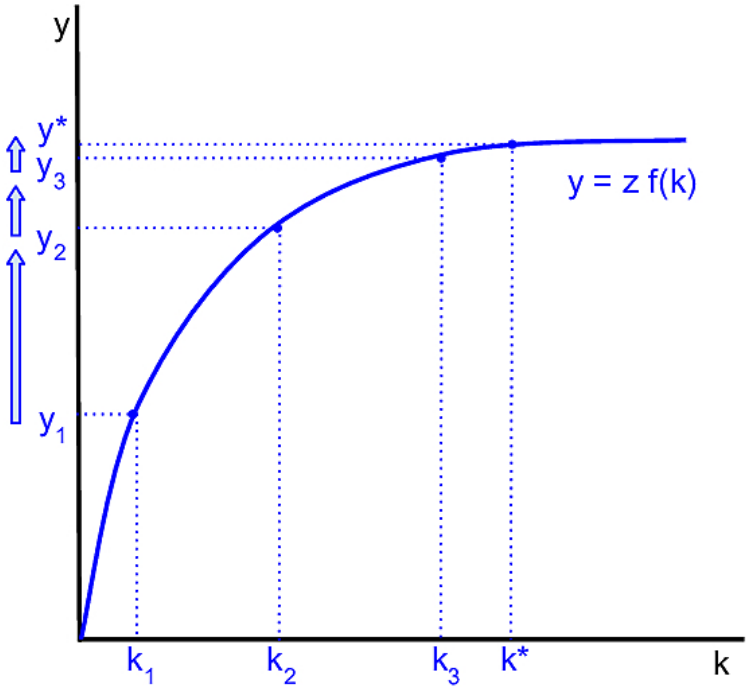


Economic Growth in Solow Model

Solow Growth: Capital Evolution



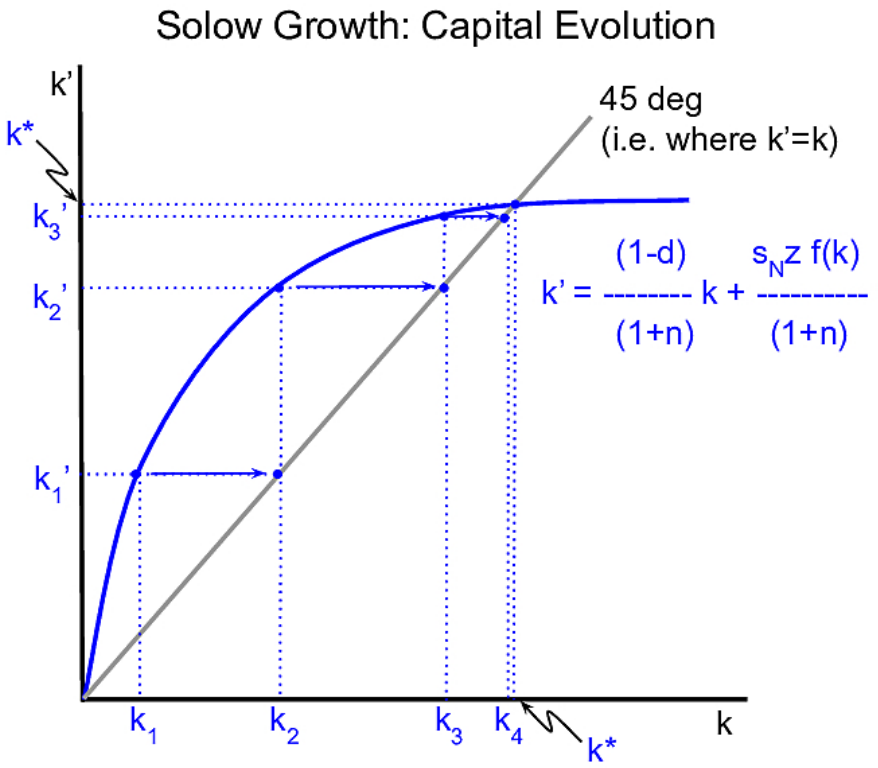
Solow Growth: Output Evolution

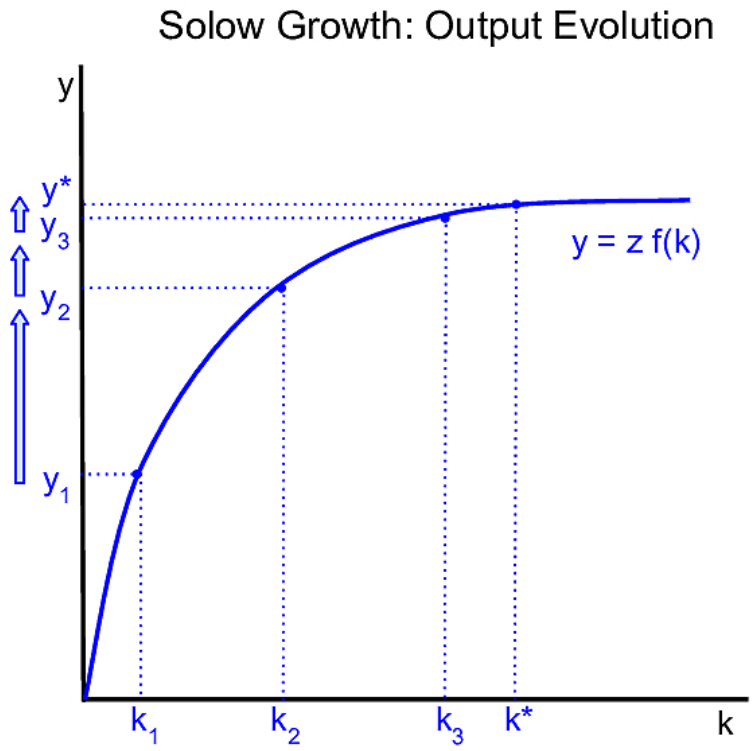


Economic Growth

- Increases in real GDP per capita higher at lower levels of capital stock per worker / lower levels of real GDP per capita
- Due to diminishing marginal product of capital

Economic Growth in Solow Model



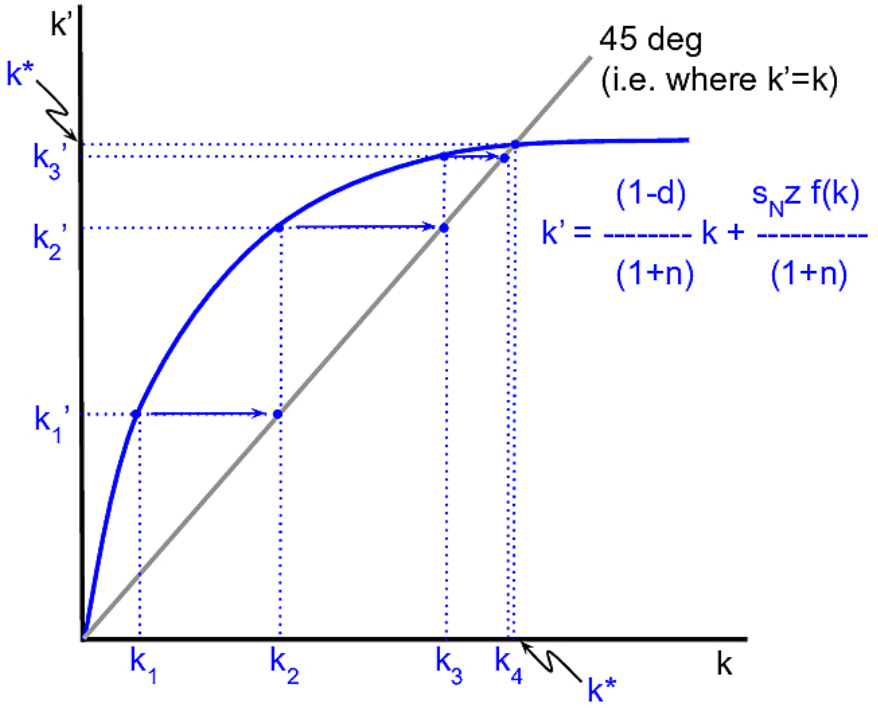


Economic Growth

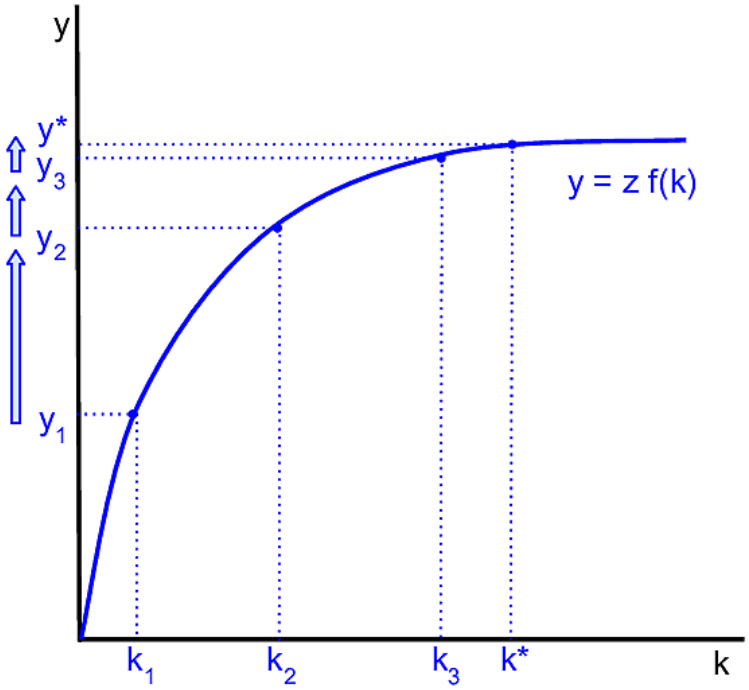
- Increases in real GDP per capita higher at lower levels of capital stock per worker / lower levels of real GDP per capita
- Due to diminishing marginal product of capital

Economic Growth in Solow Model

Solow Growth: Capital Evolution



Solow Growth: Output Evolution



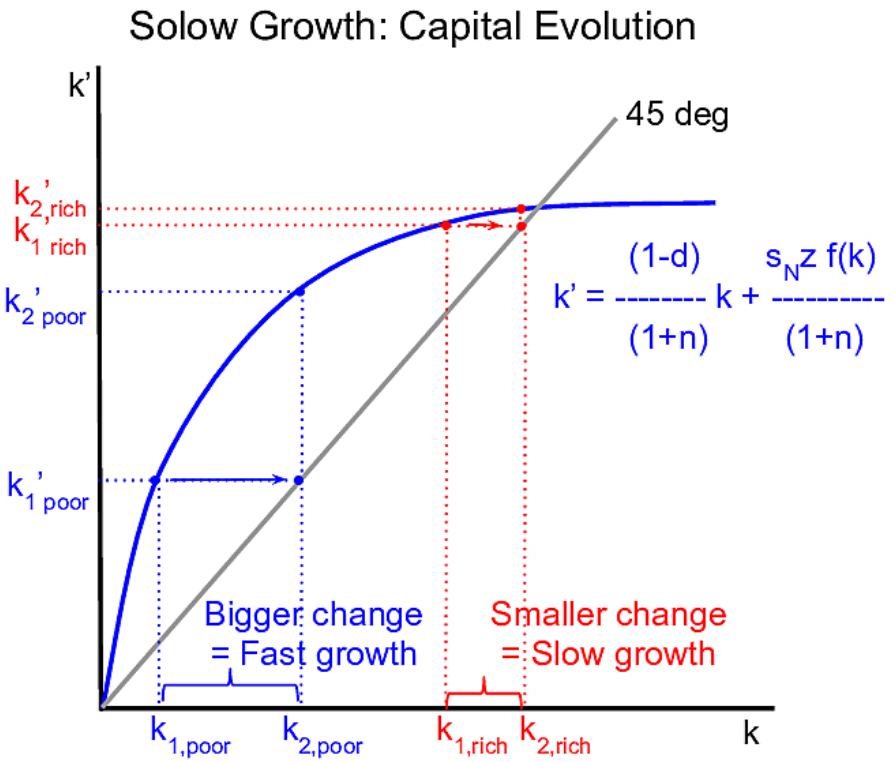
Economic Growth

- Increases in real GDP per capita higher at lower levels of capital stock per worker / lower levels of real GDP per capita
- Due to diminishing marginal product of capital

Lesser-Developed vs Develped Economies

Model Predictions

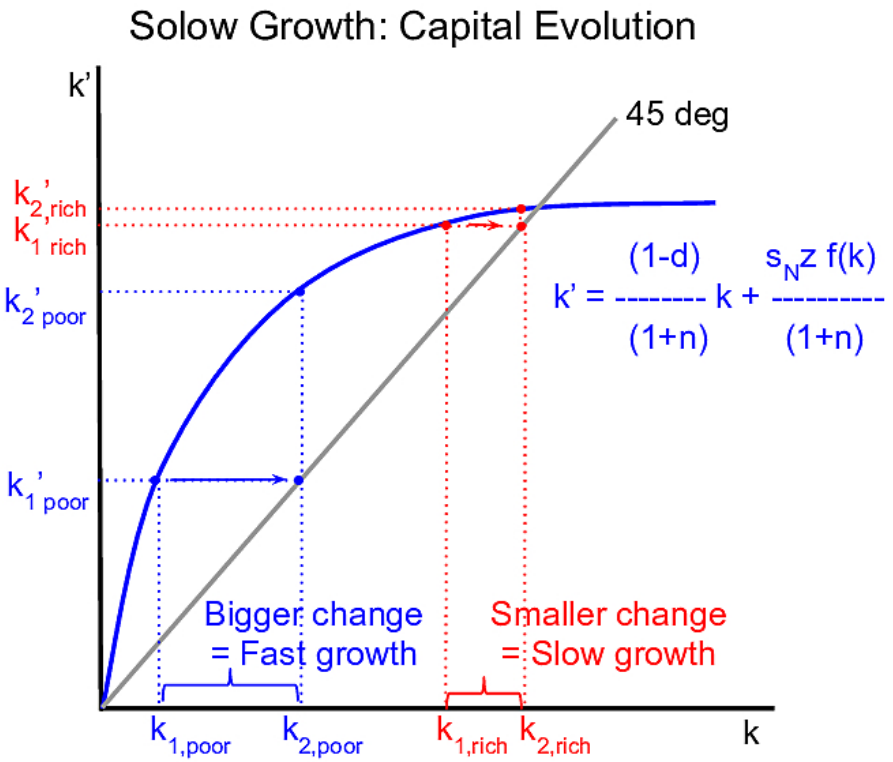
- Lesser-developed economies: Higher rates of growth in capital per worker and real GDP
- Developed economies: Slow rates of growth
- Once at steady state (k^*, y^*), only economic growth would come from shift in z
- **Convergence:** Lesser-developed economies eventually catch up to highly-developed economies



Lesser-Developed vs Develped Economies

Model Predictions

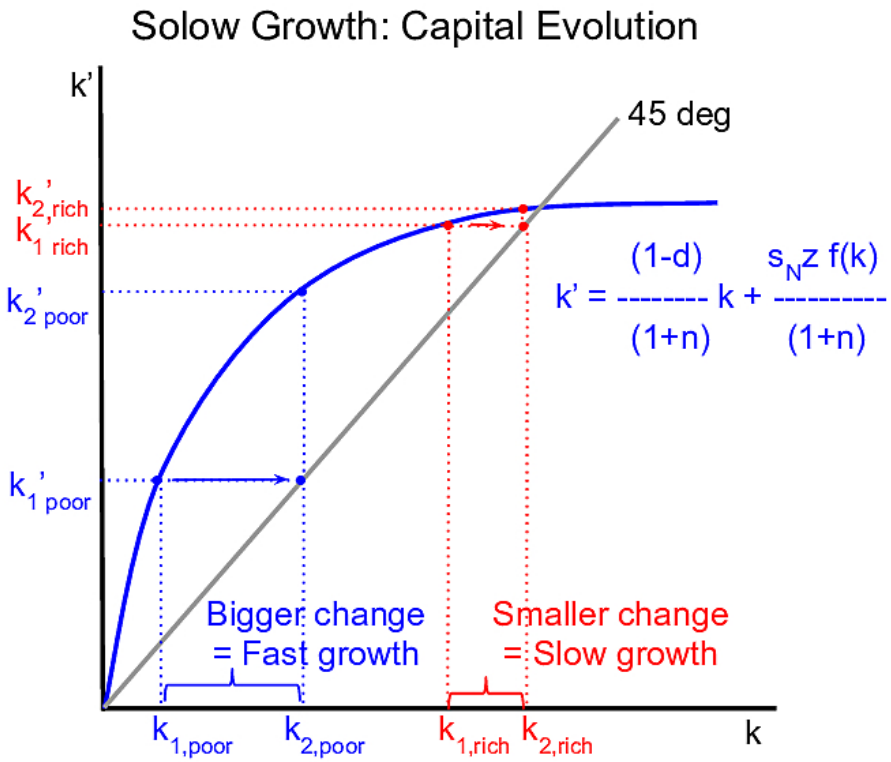
- Lesser-developed economies: Higher rates of growth in capital per worker and real GDP
- Developed economies: Slow rates of growth
- Once at steady state (k^*, y^*), only economic growth would come from shift in z
- **Convergence:** Lesser-developed economies eventually catch up to highly-developed economies



Lesser-Developed vs Develped Economies

Model Predictions

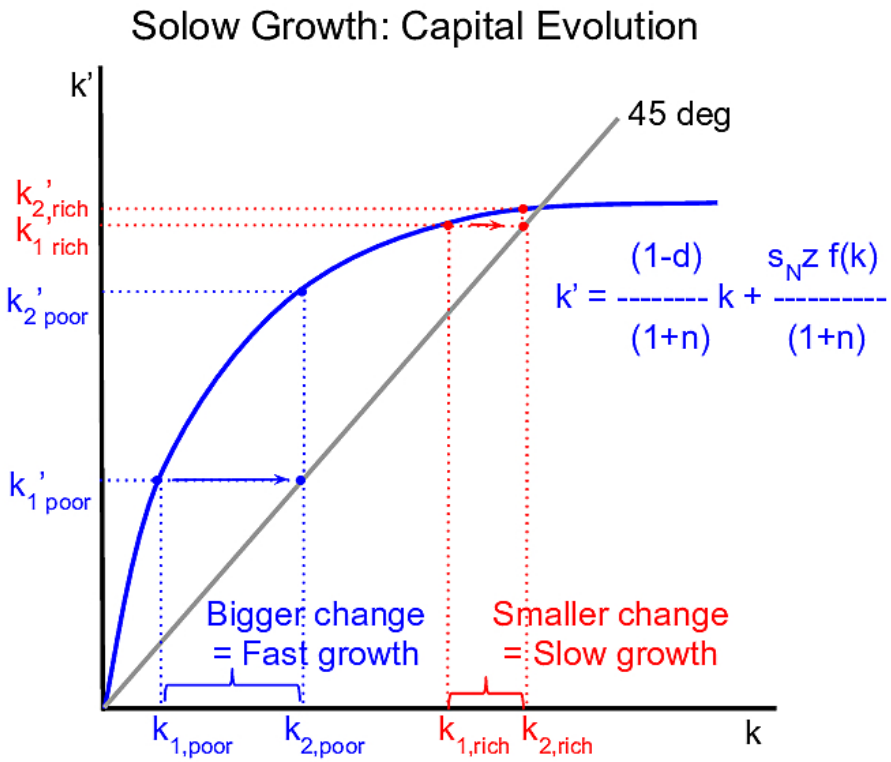
- Lesser-developed economies: Higher rates of growth in capital per worker and real GDP
- Developed economies: Slow rates of growth
- Once at steady state (k^*, y^*), only economic growth would come from shift in z
- **Convergence:** Lesser-developed economies eventually catch up to highly-developed economies



Lesser-Developed vs Develped Economies

Model Predictions

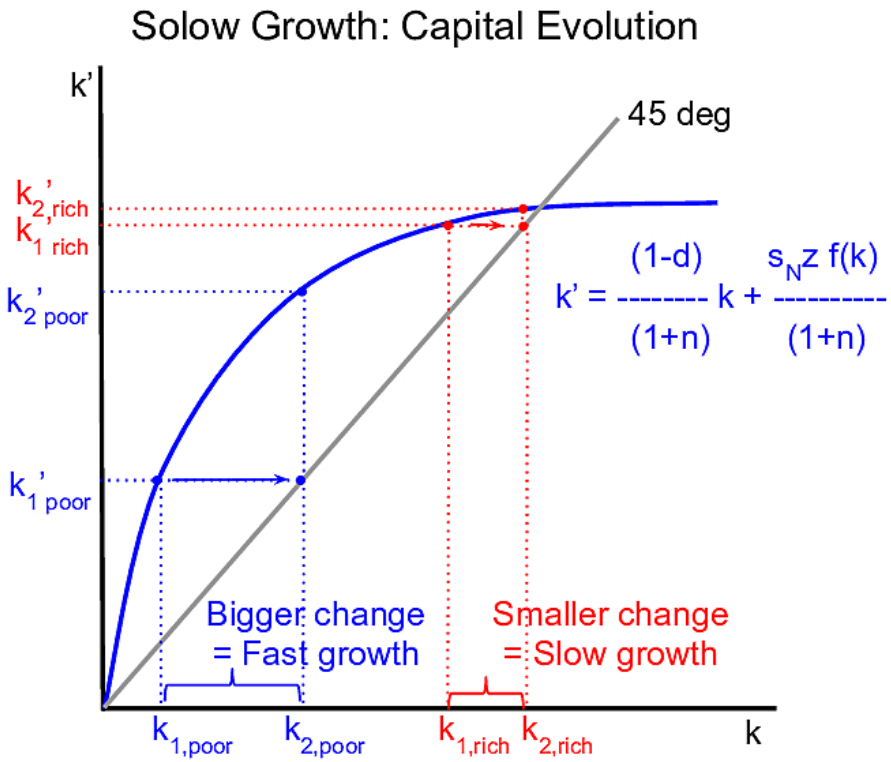
- Lesser-developed economies: Higher rates of growth in capital per worker and real GDP
- Developed economies: Slow rates of growth
- Once at steady state (k^*, y^*), only economic growth would come from shift in z
- **Convergence:** Lesser-developed economies eventually catch up to highly-developed economies



Lesser-Developed vs Develped Economies

Model Predictions

- Lesser-developed economies: Higher rates of growth in capital per worker and real GDP
- Developed economies: Slow rates of growth
- Once at steady state (k^*, y^*), only economic growth would come from shift in z
- **Convergence:** Lesser-developed economies eventually catch up to highly-developed economies



Solving for Steady State

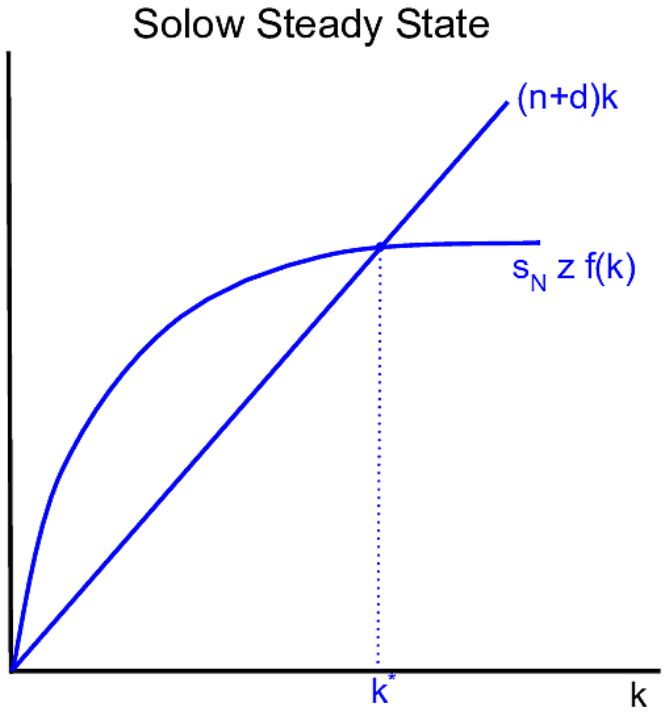
Solving for Steady State

Use the following equation, and set $k' = k = k^*$

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

$$k^* = \left(\frac{1-d}{1+n}\right)k^* + \left(\frac{s_N z}{1+n}\right)f(k^*)$$

$$(n+d)k* = s_N z f(k*)$$



Factors Affecting Steady State:

1. z: Total factor productivity
2. s_N: National savings rate
3. n: population growth rate
4. d: depreciation rate

Solving for Steady State

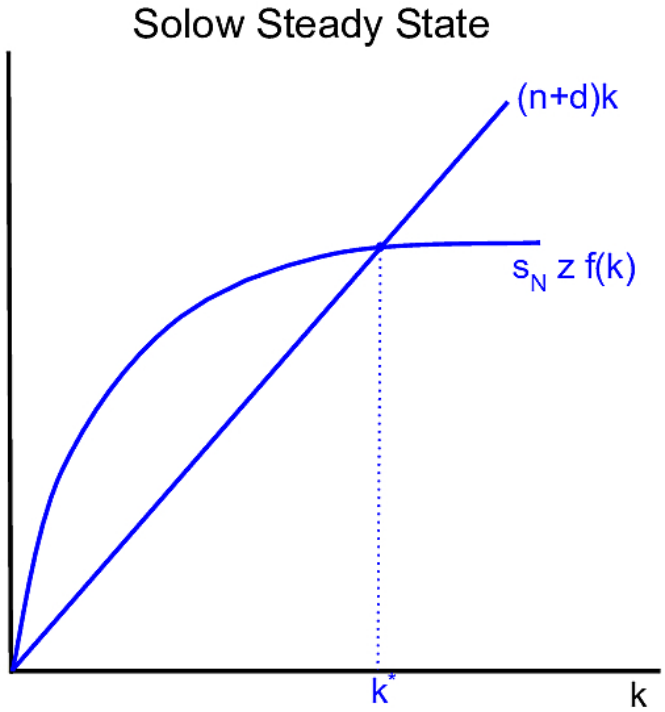
Solving for Steady State

Use the following equation, and set $k' = k = k^*$

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

$$k^* = \left(\frac{1-d}{1+n}\right)k^* + \left(\frac{s_N z}{1+n}\right)f(k^*)$$

$$(n+d)k* = s_N z f(k*)$$



Factors Affecting Steady State:

1. z: Total factor productivity
2. s_N: National savings rate
3. n: population growth rate
4. d: depreciation rate

Solving for Steady State

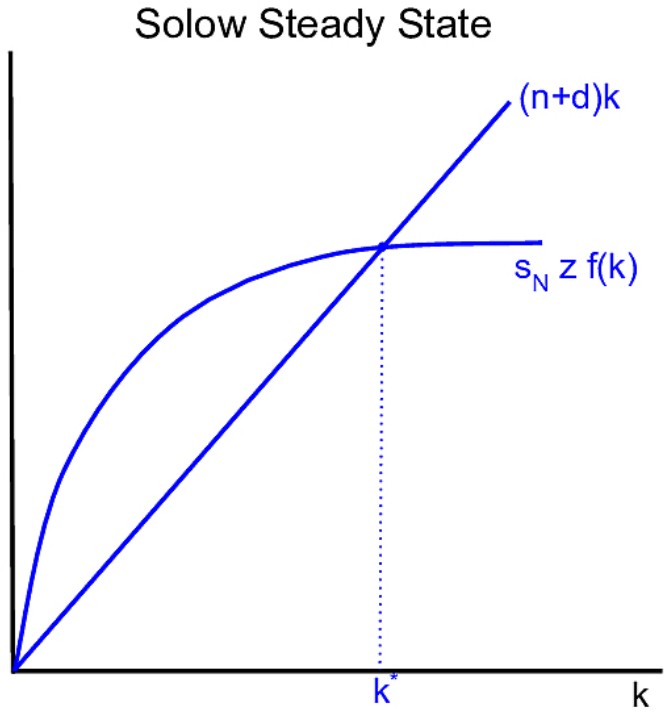
Solving for Steady State

Use the following equation, and set $k' = k = k^*$

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

$$k^* = \left(\frac{1-d}{1+n}\right)k^* + \left(\frac{s_N z}{1+n}\right)f(k^*)$$

$$(n+d)k* = s_N z f(k*)$$



Factors Affecting Steady State:

1. z: Total factor productivity
2. s_N: National savings rate
3. n: population growth rate
4. d: depreciation rate

Solving for Steady State

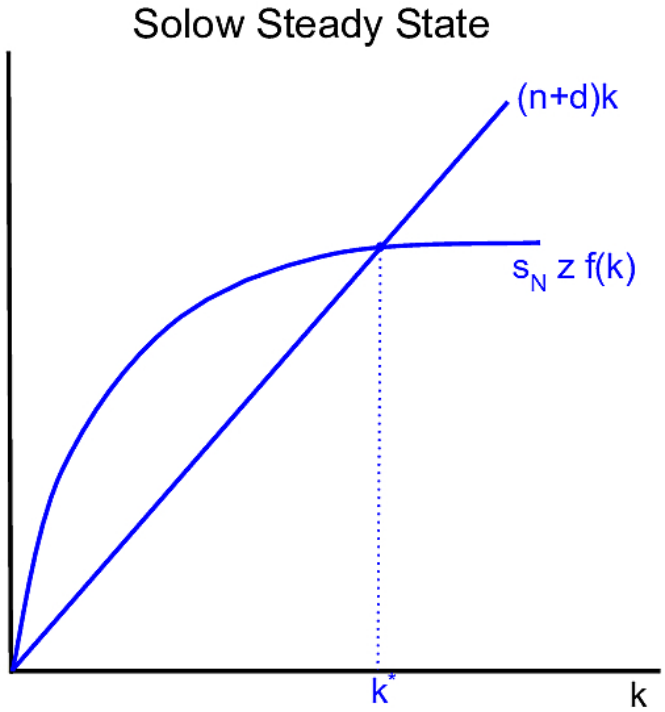
Solving for Steady State

Use the following equation, and set $k' = k = k^*$

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

$$k^* = \left(\frac{1-d}{1+n}\right)k^* + \left(\frac{s_N z}{1+n}\right)f(k^*)$$

$$(n+d)k* = s_N z f(k*)$$



Factors Affecting Steady State:

1. z: Total factor productivity
2. s_N: National savings rate
3. n: population growth rate
4. d: depreciation rate

Solving for Steady State

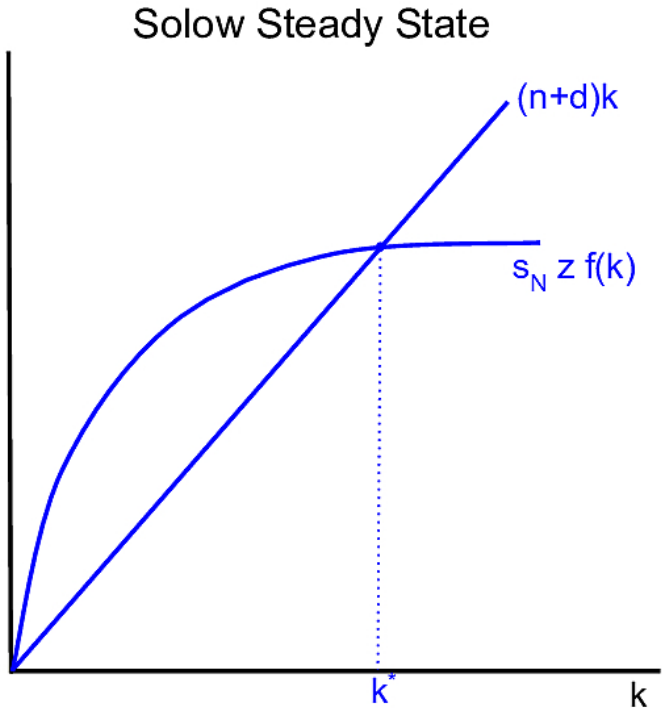
Solving for Steady State

Use the following equation, and set $k' = k = k^*$

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

$$k^* = \left(\frac{1-d}{1+n}\right)k^* + \left(\frac{s_N z}{1+n}\right)f(k^*)$$

$$(n+d)k* = s_N z f(k*)$$



Factors Affecting Steady State:

1. z: Total factor productivity
2. s_N: National savings rate
3. n: population growth rate
4. d: depreciation rate

Solving for Steady State

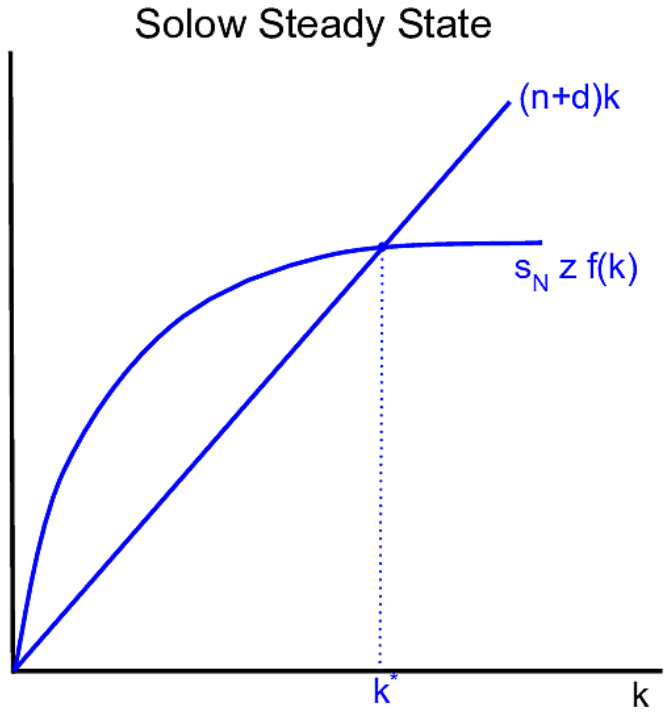
Solving for Steady State

Use the following equation, and set $k' = k = k^*$

$$k' = \left(\frac{1-d}{1+n}\right)k + \left(\frac{s_N z}{1+n}\right)f(k)$$

$$k^* = \left(\frac{1-d}{1+n}\right)k^* + \left(\frac{s_N z}{1+n}\right)f(k^*)$$

$$(n+d)k* = s_N z f(k*)$$



Factors Affecting Steady State:

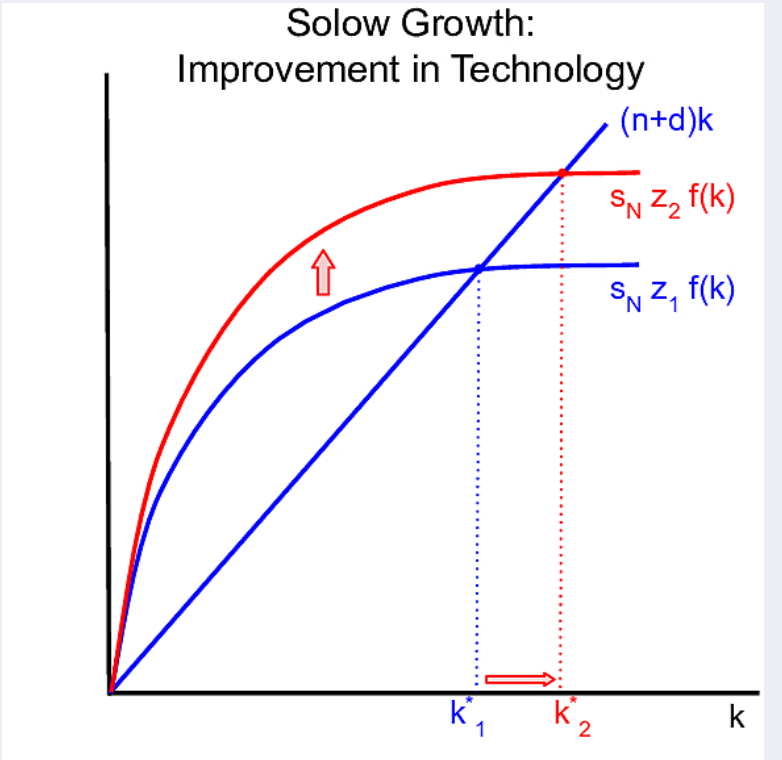
1. z: Total factor productivity
2. s_N: National savings rate
3. n: population growth rate
4. d: depreciation rate

Total Factor Productivity

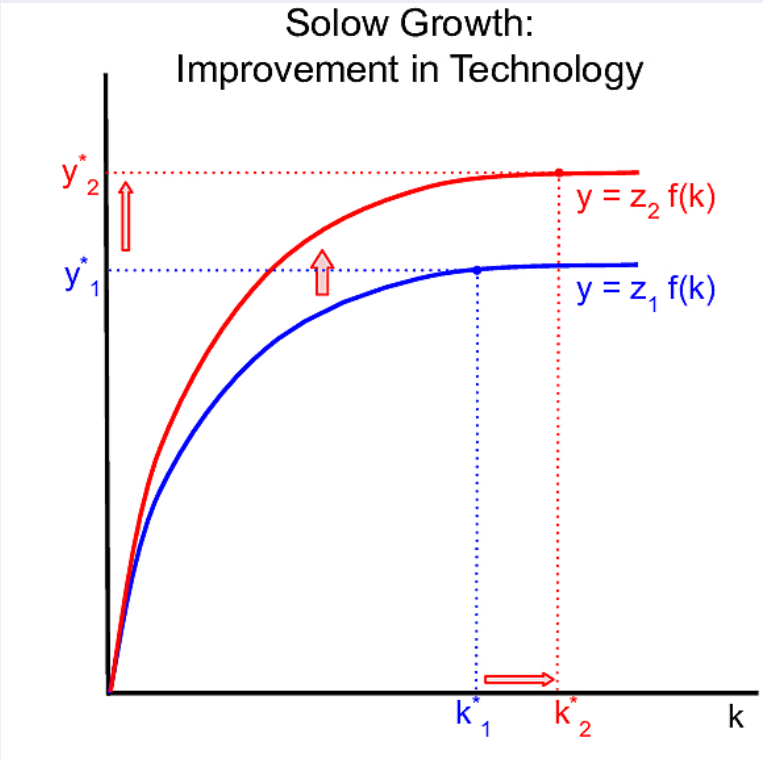
Improvement in Total Factor Productivity

- Increase in z causes production function and $s_N z f(k^*)$ to pivot upward
- Result: Higher k^* and y^*, i.e. higher steady state level of capital per worker, higher real GDP per capita

Capital Per-Worker



Output Per-Worker

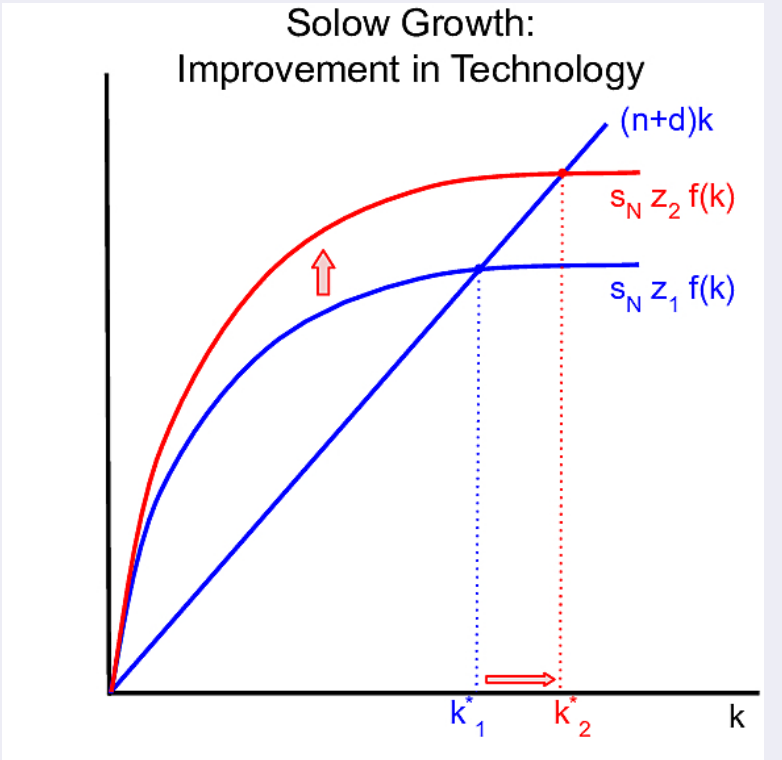


Total Factor Productivity

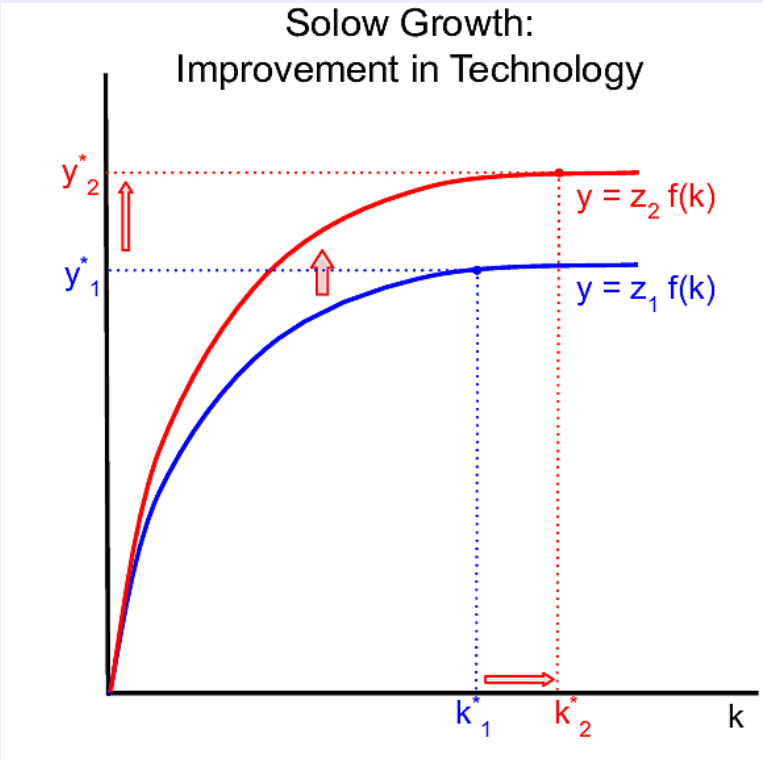
Improvement in Total Factor Productivity

- Increase in z causes production function and $s_N z f(k^*)$ to pivot upward
- Result: Higher k^* and y^*, i.e. higher steady state level of capital per worker, higher real GDP per capita

Capital Per-Worker



Output Per-Worker

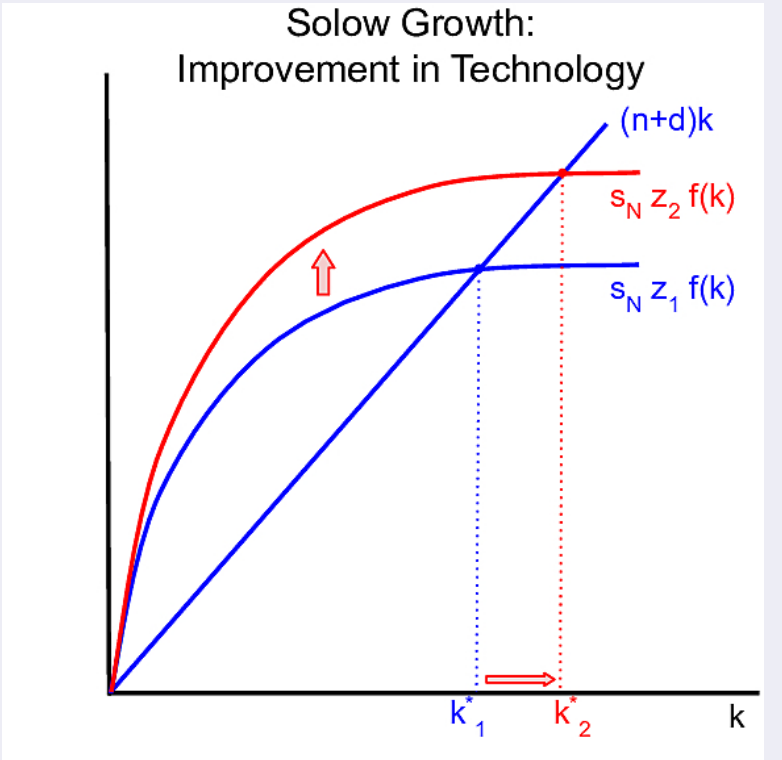


Total Factor Productivity

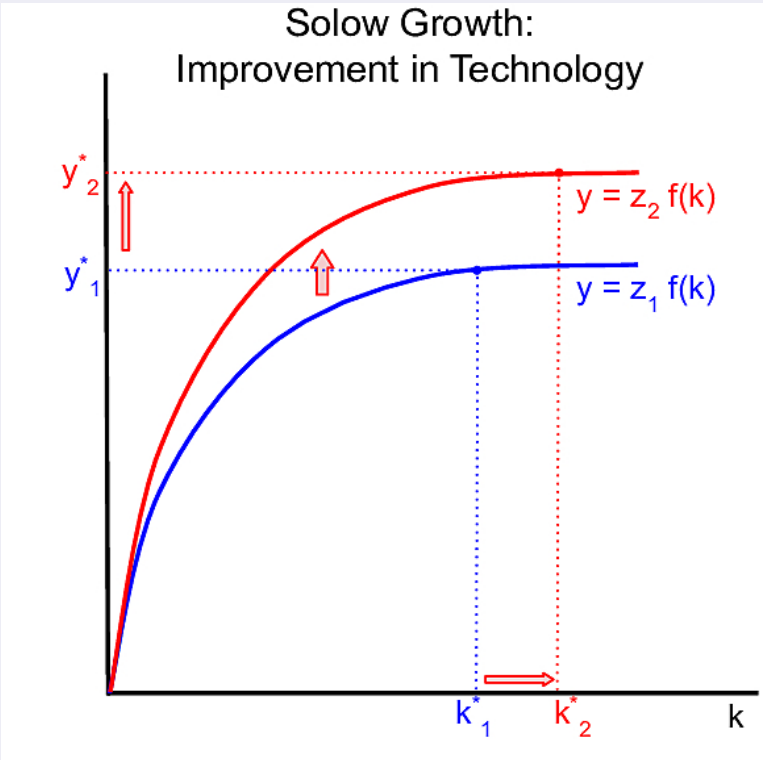
Improvement in Total Factor Productivity

- Increase in z causes production function and $s_N z f(k^*)$ to pivot upward
- Result: Higher k^* and y^*, i.e. higher steady state level of capital per worker, higher real GDP per capita

Capital Per-Worker



Output Per-Worker

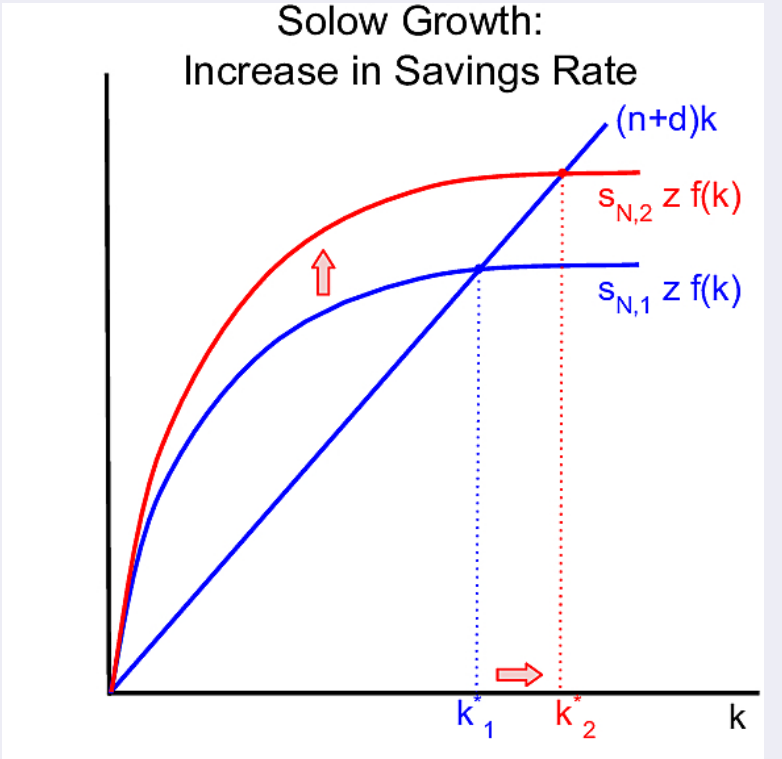


National Savings Rate

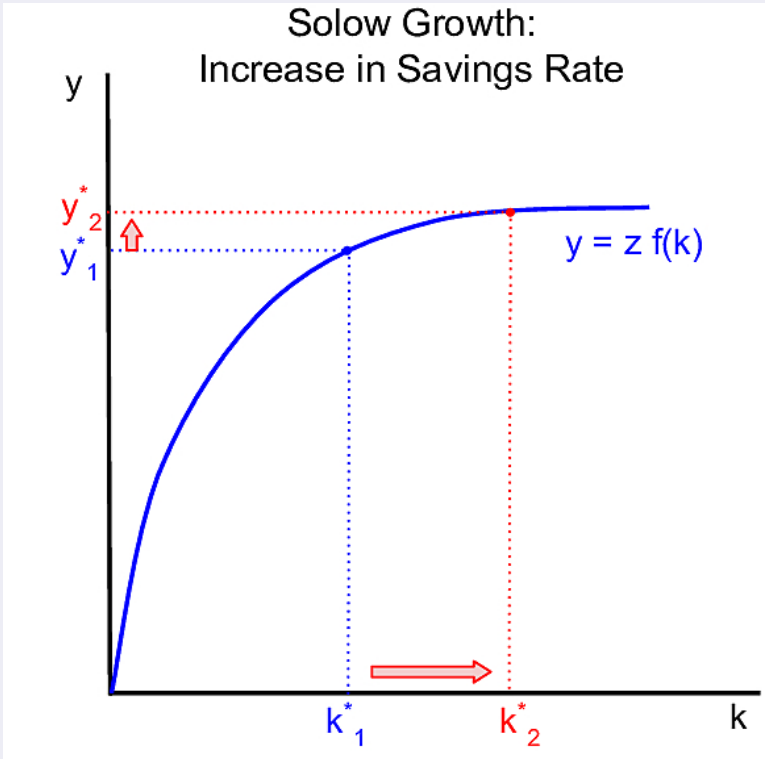
Increase in national savings rate

- Increase in s_N causes $s_N z f(k^*)$ to pivot upward, but no change in production function
- Result: Higher k^* and y^*, i.e. higher steady state level of capital per worker, higher real GDP per capita

Capital Per-Worker



Output Per-Worker

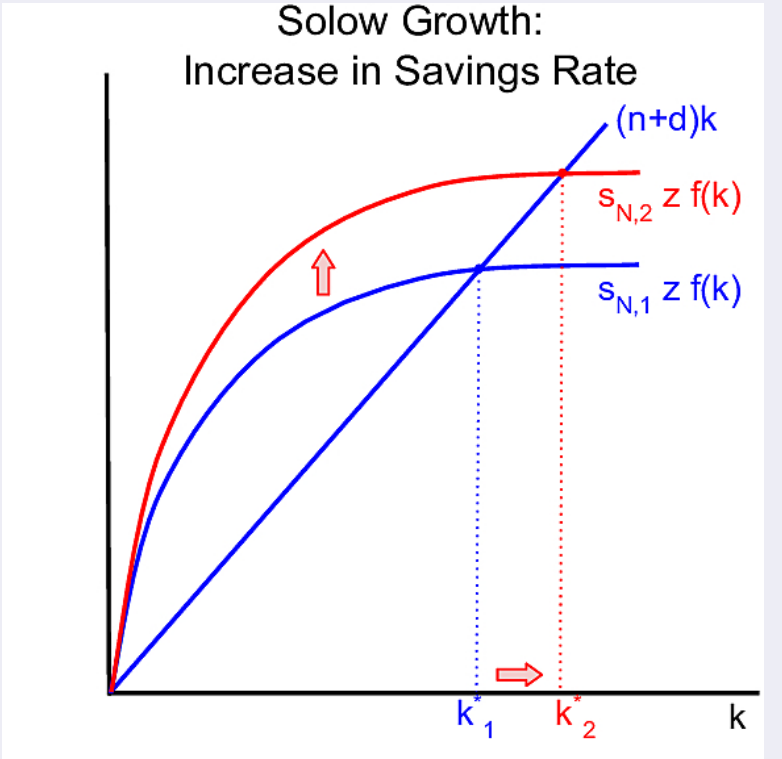


National Savings Rate

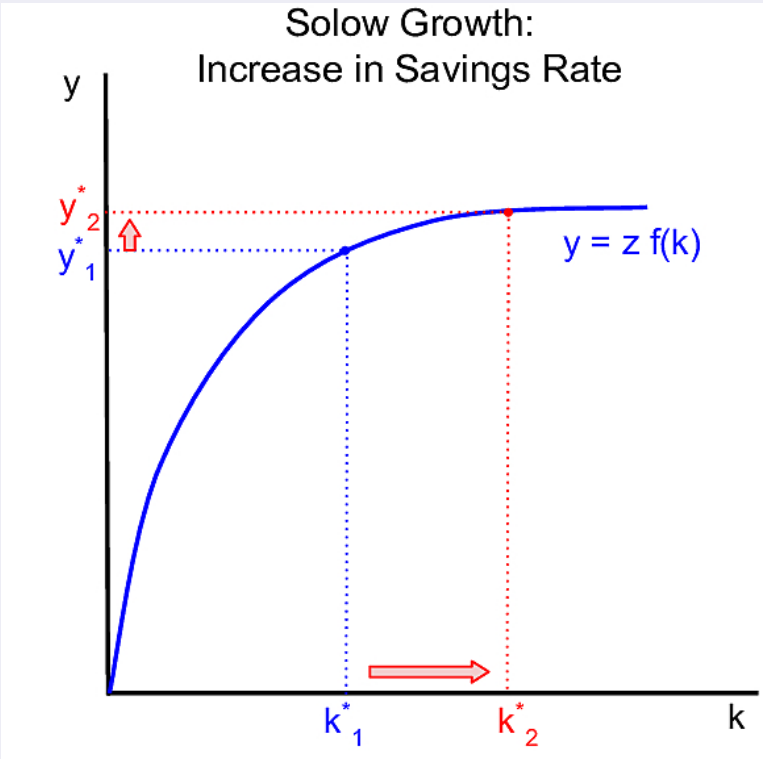
Increase in national savings rate

- Increase in s_N causes $s_N z f(k^*)$ to pivot upward, but no change in production function
- Result: Higher k^* and y^*, i.e. higher steady state level of capital per worker, higher real GDP per capita

Capital Per-Worker



Output Per-Worker

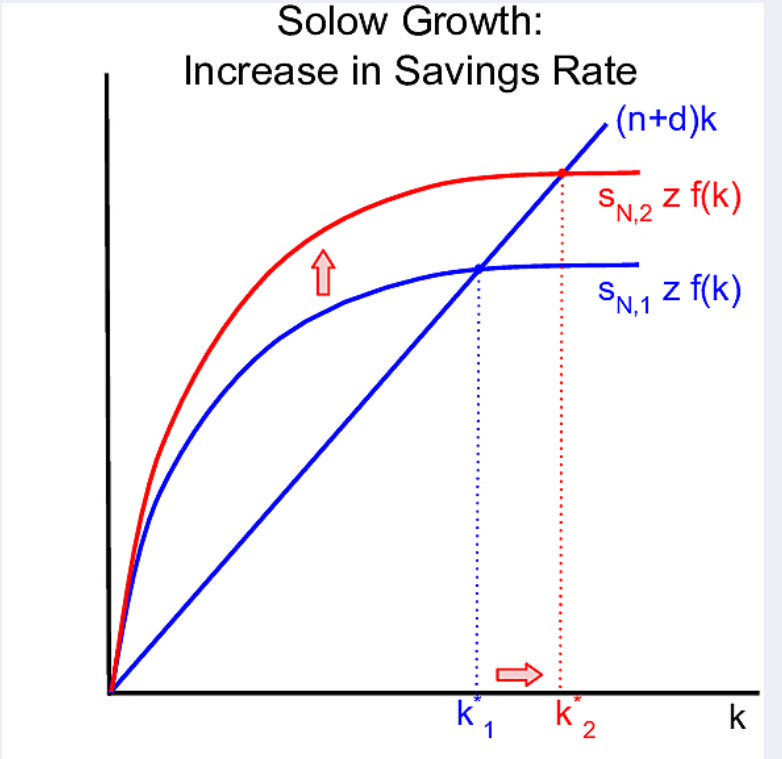


National Savings Rate

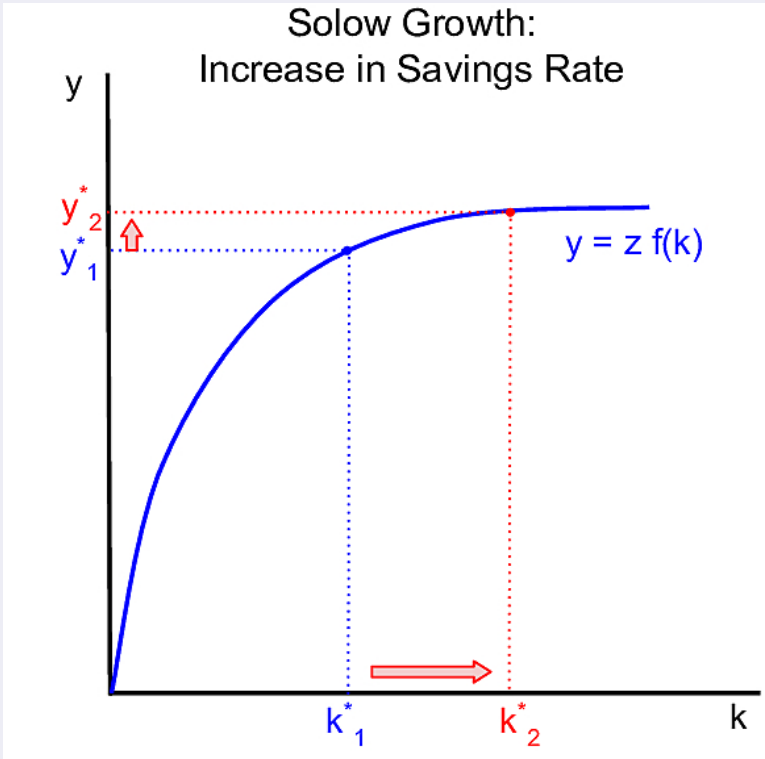
Increase in national savings rate

- Increase in s_N causes $s_N z f(k^*)$ to pivot upward, but no change in production function
- Result: Higher k^* and y^*, i.e. higher steady state level of capital per worker, higher real GDP per capita

Capital Per-Worker



Output Per-Worker

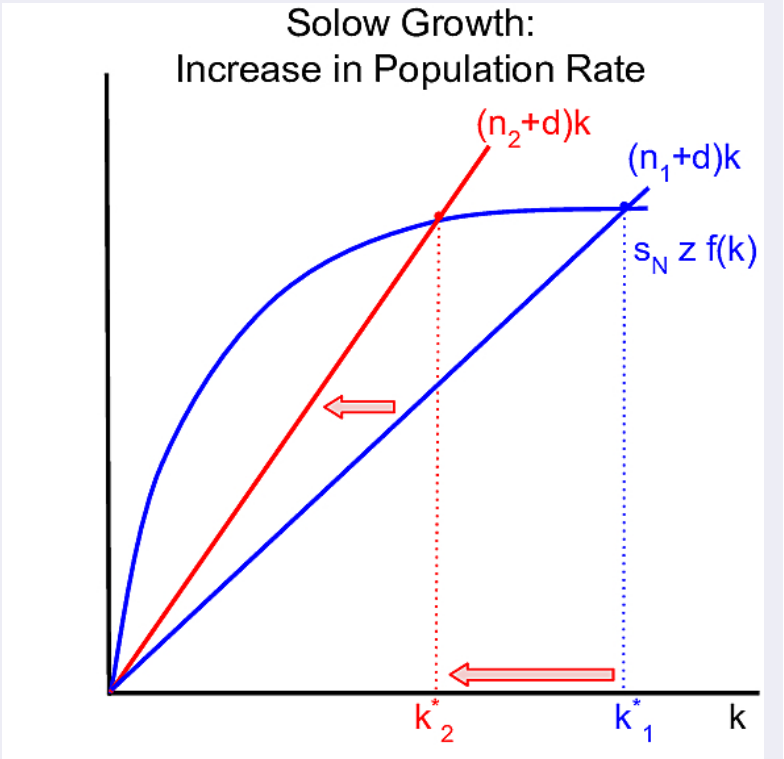


Population Growth Rate

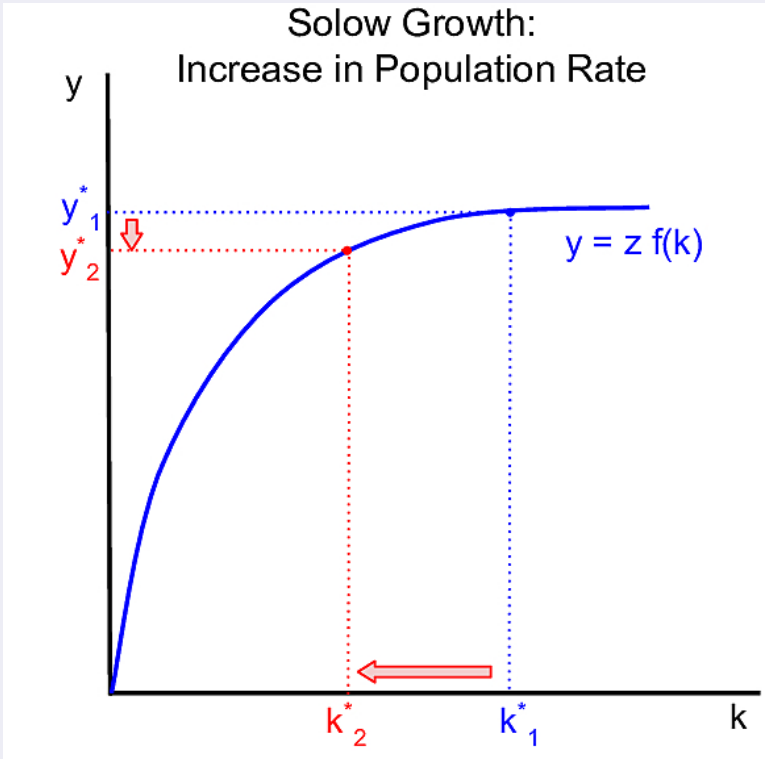
Increase in Population Growth Rate

- Increase in n causes $(n+d)k$ line to pivot upward
- Result: Lower k^* and y^*, i.e. lower steady state level of capital per worker, lower real GDP per capita

Capital Per-Worker



Output Per-Worker

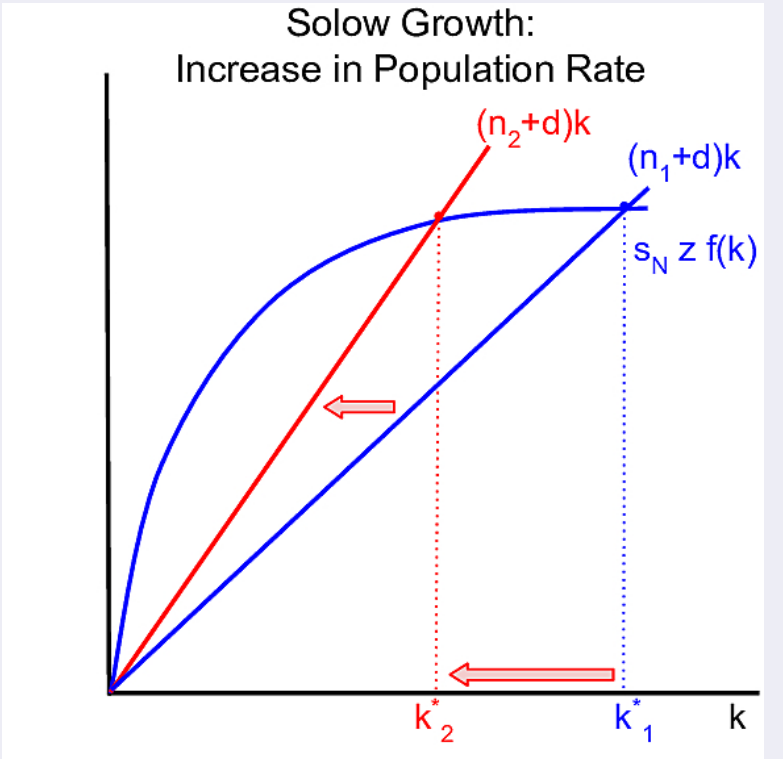


Population Growth Rate

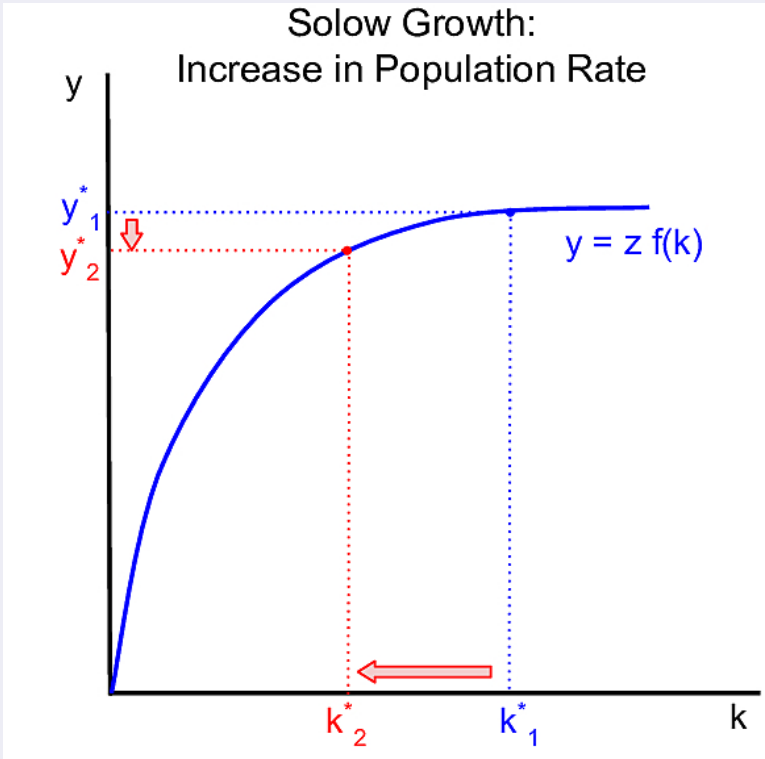
Increase in Population Growth Rate

- Increase in n causes $(n+d)k$ line to pivot upward
- Result: Lower k^* and y^*, i.e. lower steady state level of capital per worker, lower real GDP per capita

Capital Per-Worker



Output Per-Worker

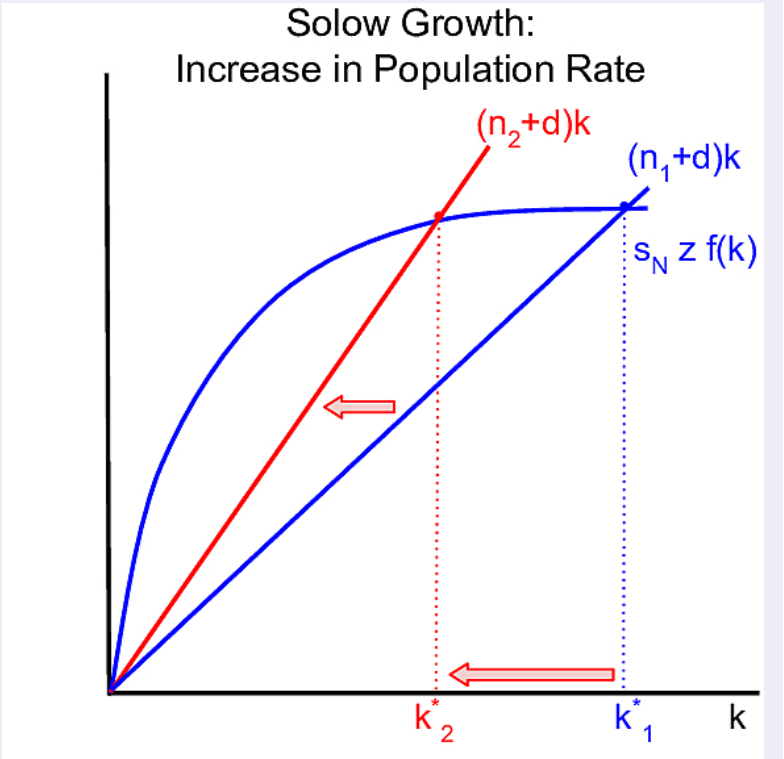


Population Growth Rate

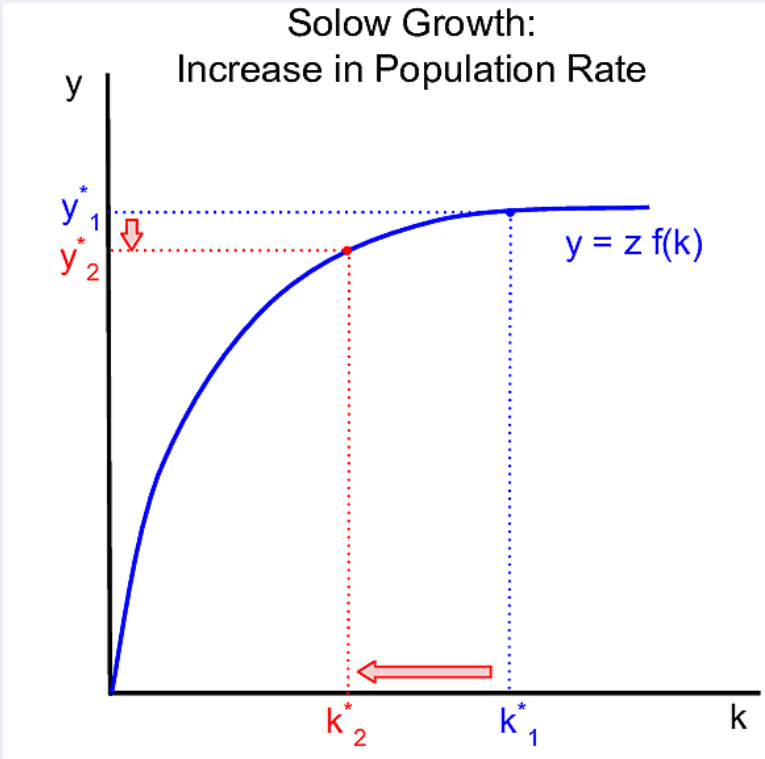
Increase in Population Growth Rate

- Increase in n causes $(n+d)k$ line to pivot upward
- Result: Lower k^* and y^*, i.e. lower steady state level of capital per worker, lower real GDP per capita

Capital Per-Worker



Output Per-Worker

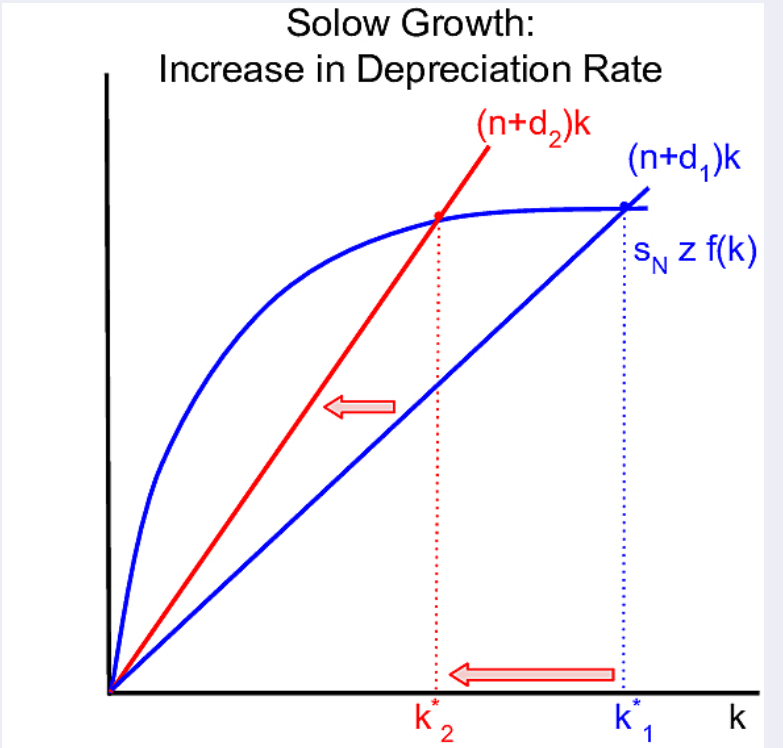


Depreciation Rate

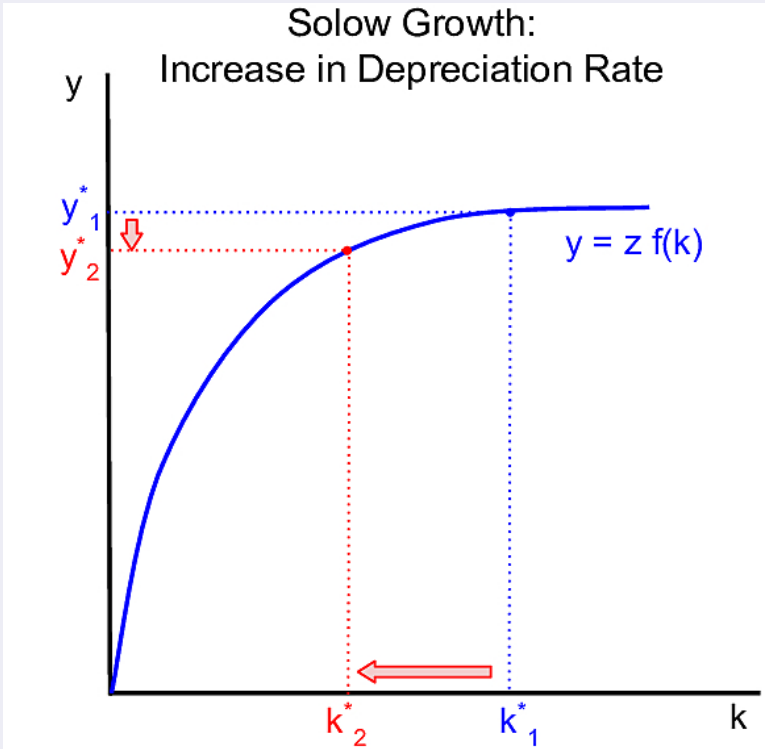
Increase in Depreciation Rate of Capital

- Increase in d causes $(n+d)k$ line to pivot upward
- Result: Lower k^* and y^*, i.e. lower steady state level of capital per worker, lower real GDP per capita

Capital Per-Worker



Output Per-Worker

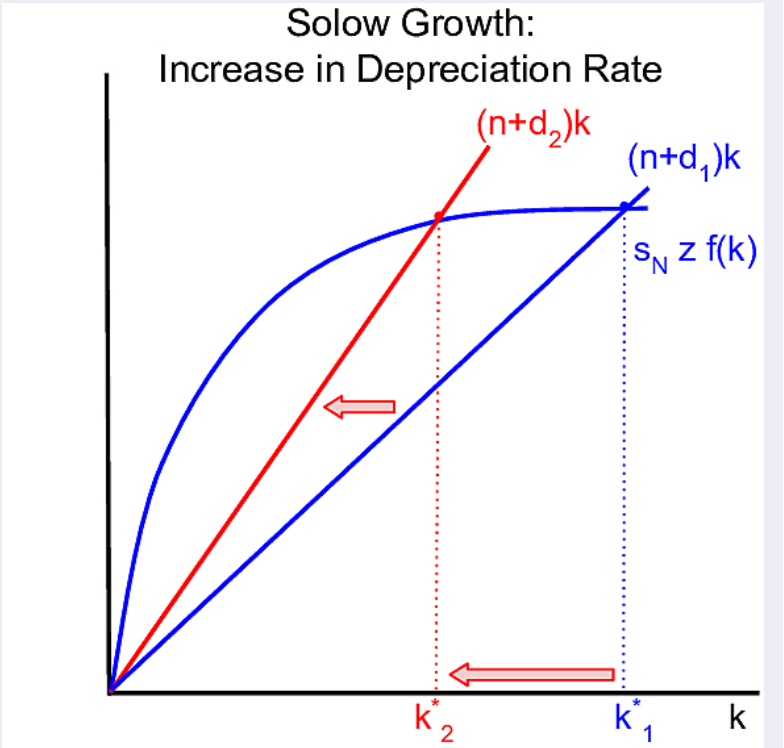


Depreciation Rate

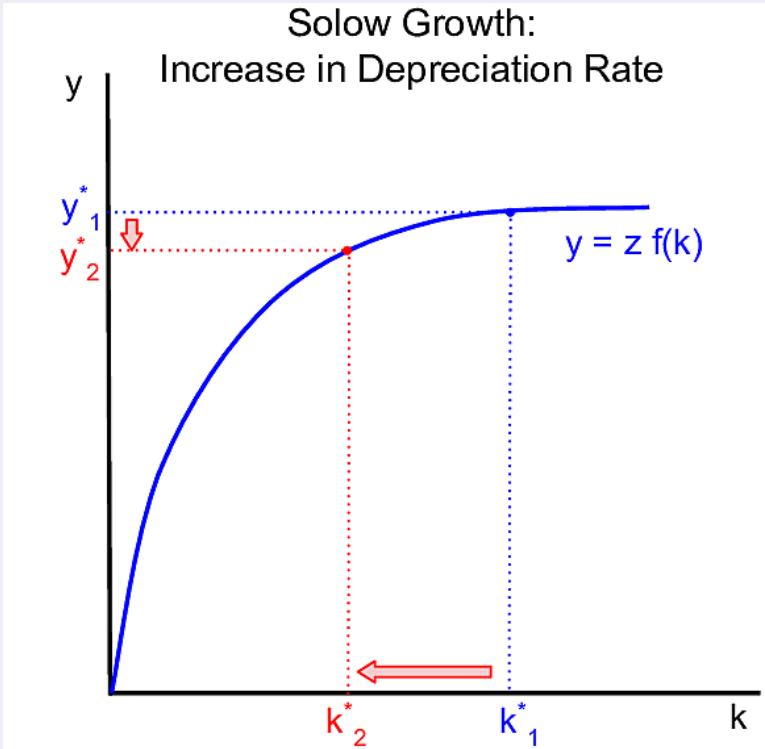
Increase in Depreciation Rate of Capital

- Increase in d causes $(n+d)k$ line to pivot upward
- Result: Lower k^* and y^*, i.e. lower steady state level of capital per worker, lower real GDP per capita

Capital Per-Worker



Output Per-Worker

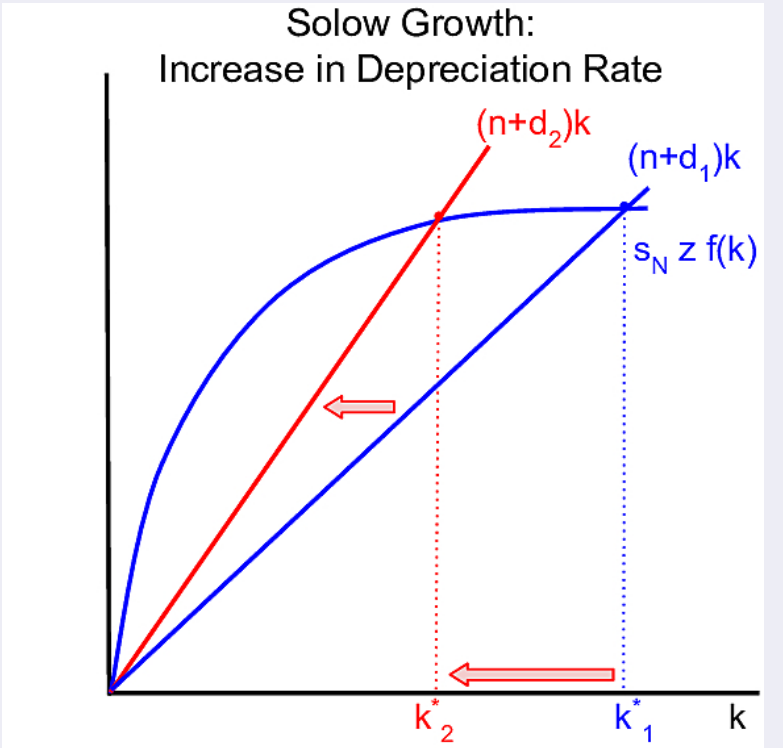


Depreciation Rate

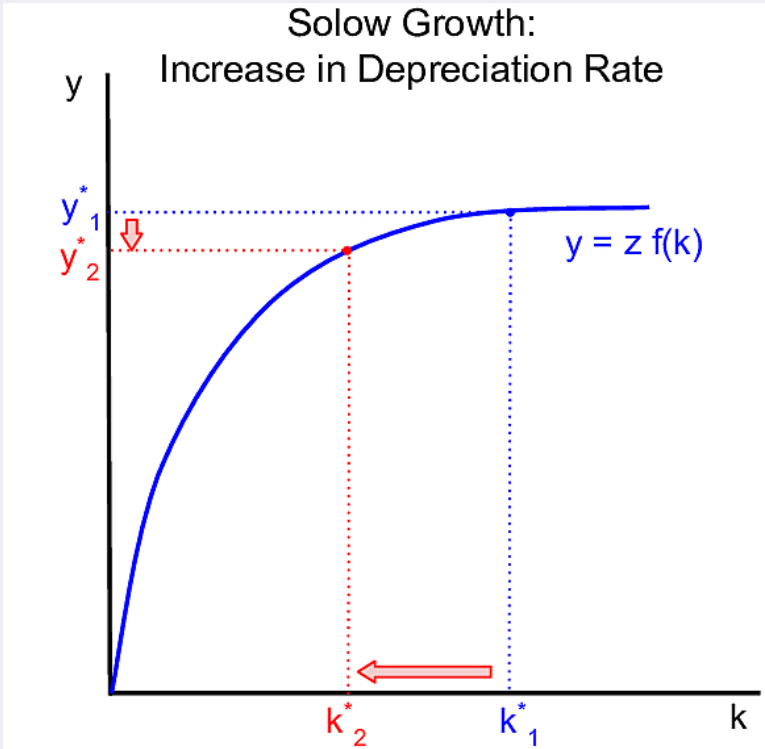
Increase in Depreciation Rate of Capital

- Increase in d causes $(n+d)k$ line to pivot upward
- Result: Lower k^* and y^*, i.e. lower steady state level of capital per worker, lower real GDP per capita

Capital Per-Worker



Output Per-Worker



Model Shortcomings

- Not all lesser-developed countries have high rates of growth
- Not all lesser-developed countries are catching up
- Increasing returns to scale, increasing marginal product of capital, possible for lesser-developed economies
- Fails to account for human capital in economic growth

Model Shortcomings

- Not all lesser-developed countries have high rates of growth
- Not all lesser-developed countries are catching up
- Increasing returns to scale, increasing marginal product of capital, possible for lesser-developed economies
- Fails to account for human capital in economic growth

Model Shortcomings

- Not all lesser-developed countries have high rates of growth
- Not all lesser-developed countries are catching up
- Increasing returns to scale, increasing marginal product of capital, possible for lesser-developed economies
- Fails to account for human capital in economic growth

Model Shortcomings

- Not all lesser-developed countries have high rates of growth
- Not all lesser-developed countries are catching up
- Increasing returns to scale, increasing marginal product of capital, possible for lesser-developed economies
- Fails to account for human capital in economic growth