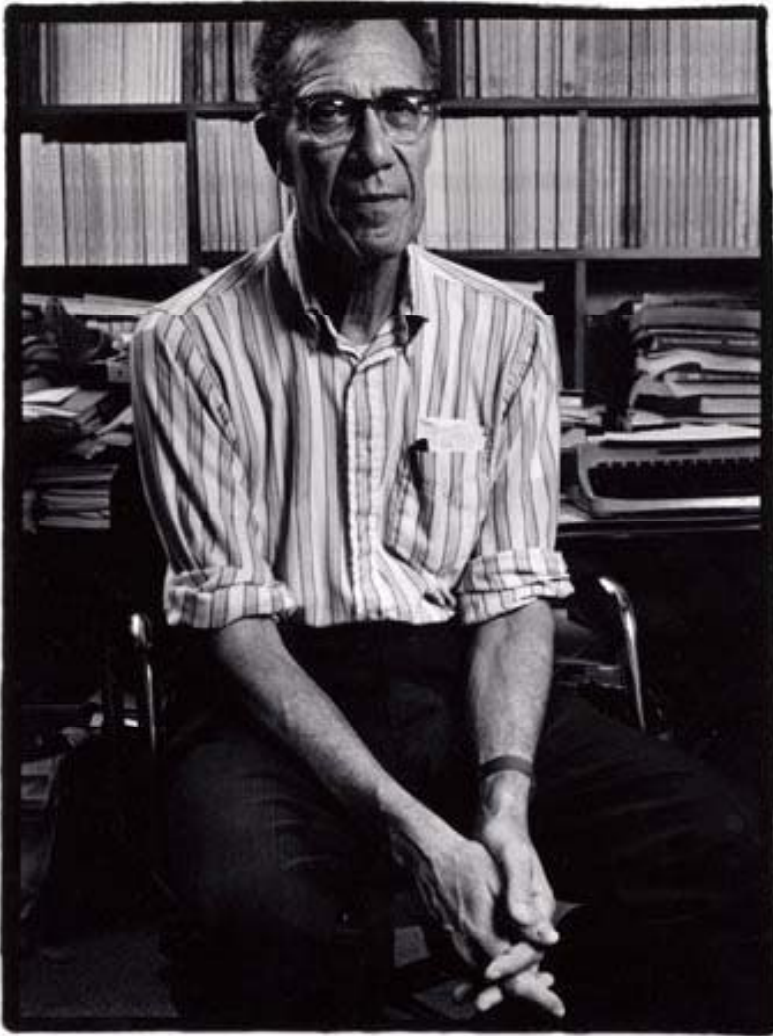


Robert Merton Solow



Robert M. Solow, Nobel Laureate
11/19/2008

Cambridge, 1987

1924-????

Danny Tan

Background

- Born in Brooklyn, New York on August 23, 1924, the oldest of three children.
- Was educated in the neighborhood public schools of New York City and first in his family to attend a University.
- Not very intellectual until the last year in high school, a teacher encouraged him to understand the great 19th century French and Russian novelists, and to take ideas seriously.
- In September 1940, Solow went to the Harvard College with a scholarship. At Harvard, his first studies were in sociology and anthropology as well as elementary economics.

Background – Influenced by – Contributions – Impact - Critique

- By the end of 1942, Solow left the university and joined the U.S. Army. He served briefly in North Africa and Sicily, and later served in Italy during World War II until he was discharged in August 1945.
- He returned to Harvard in 1945, and studied under **Wassily Leontief**. As his research assistant he produced the first set of capital-coefficients for the input-output model.
- From 1949-50, he spent a fellowship year at Columbia University to study statistics more intensively. During that year he was also working on his Ph.D.
- In 1949, just before going off to Columbia he was offered and accepted an Assistant Professorship in the Economics Department at Massachusetts Institute of Technology. At M.I.T. he taught courses in statistics and econometrics. Solow's interest gradually changed to Macroeconomics.

Background – Influenced by – Contributions – Impact - Critique

- For almost 40 years, Solow and Paul Samuelson worked together on many landmark theories: von Neumann growth theory (1953), capital theory(1956), linear programming(1958) and the Philips Curve(1960).
- Solow also held several government positions, including senior economist for the Council of Economic Advisers (1961–62) and member of the President’s Commission on Income Maintenance (1968–70). His studies focused mainly in the fields of employment and growth policies, and the theory of capital.
- In 1961 he won the American Economic Association's John Bates Clark Award, given to the best economist under age forty.
- In 1979 he was president of that association.
- In 1987, Robert Solow won the Nobel Prize for his analysis of economic growth.
- In 1999, he received National Medal of Science



Influence

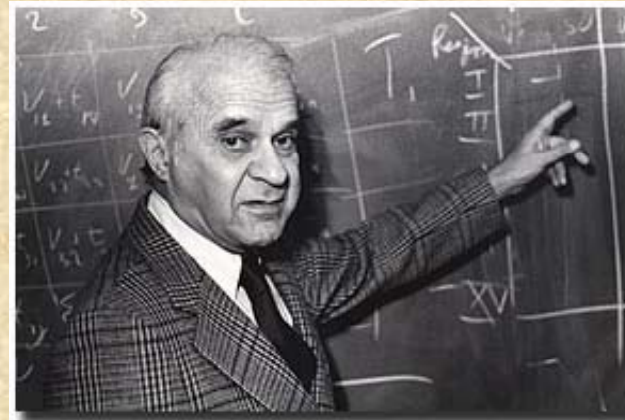
- **Frederick Mosteller**, whose appointment was in the Department of Social Relations, advised Solow to study more intensively in a place where that was possible. (statistics)
- He was the founding chairman of Harvard's statistics department, from 1957 to 1971
- Served as the president of several professional bodies including the Psychometric Society, the American Statistical Association, the Institute of Mathematical Statistics, the American Association for the Advancement of Science, and the International Statistical Institute.



1916-2006

Background – **Influenced by** – Contributions – Impact - Critique

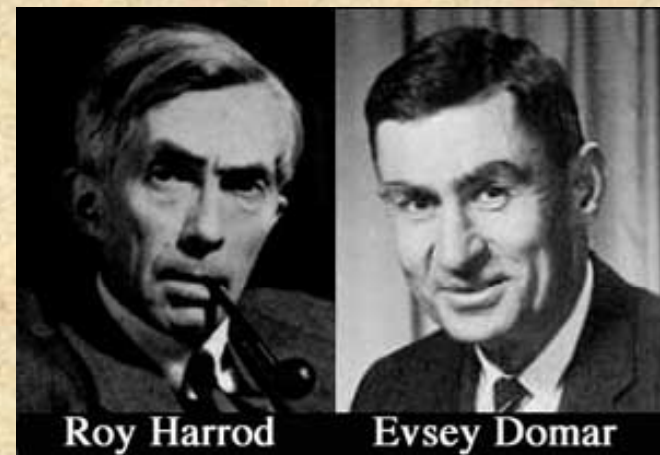
- **Wassily Wassilyovitch Leontief** was an economist notable for his research on how changes in one economic sector may have an effect on other sectors.
- Leontief is primarily associated with the development of the linear activity model of General equilibrium and the use of input-output analysis that results from it.
- Made contributions in other areas of economics, such as international trade where he documented the famous Leontief paradox.



1905- 1999

Background – Influenced by – Contributions – Impact - Critique

- **Sir Roy F. Harrod and Evsey Domar**
- The **Harrod-Domar model** is used in development economics to explain an economy's growth rate in terms of the level of saving and productivity of capital.
- The Harrod-Domar model was the precursor to the Exogenous Growth model.
- Harrod introduced the concepts of warranted growth, natural growth, and actual growth. The warranted growth rate is the growth rate at which all **saving** is absorbed into **INVESTMENT**.
- The main difference between the Harrod-Domar and the Solow model, is that Solow relaxed their assumption that labor and capital are used in fixed proportions in the production of output.



Roy Harrod

Evsey Domar

1990-1978

1914-1997

Contribution

- Solow's growth model was presented in an article entitled, A Contribution to the Theory of Economic Growth (1956).

Contribution

- *From press release: "The study of the factors which permit production growth and increased welfare has been a central feature in economic research for many years. Robert M. Solow's prize recognizes his exceptional contributions in this area. It is eminently reasonable to imagine that increased per capita production in a country may be the result of **more machines** and more factories (a greater stock of real capital). But this increased production may also be due to improved machines and more efficient production methods (which may be termed **technical development**). In addition, better education and training, and improved methods of organizing production may also give rise to increased productivity. The discovery of fresh natural resources, or improvements in a country's position on the world market, may also lead to higher standards of living. Solow has created a theoretical framework which can be used in discussing the factors which lie behind economic growth in both quantitative and theoretical terms. This framework can also be exploited to measure empirically the contributions made by various production factors in economic growth."*

Two Important Questions

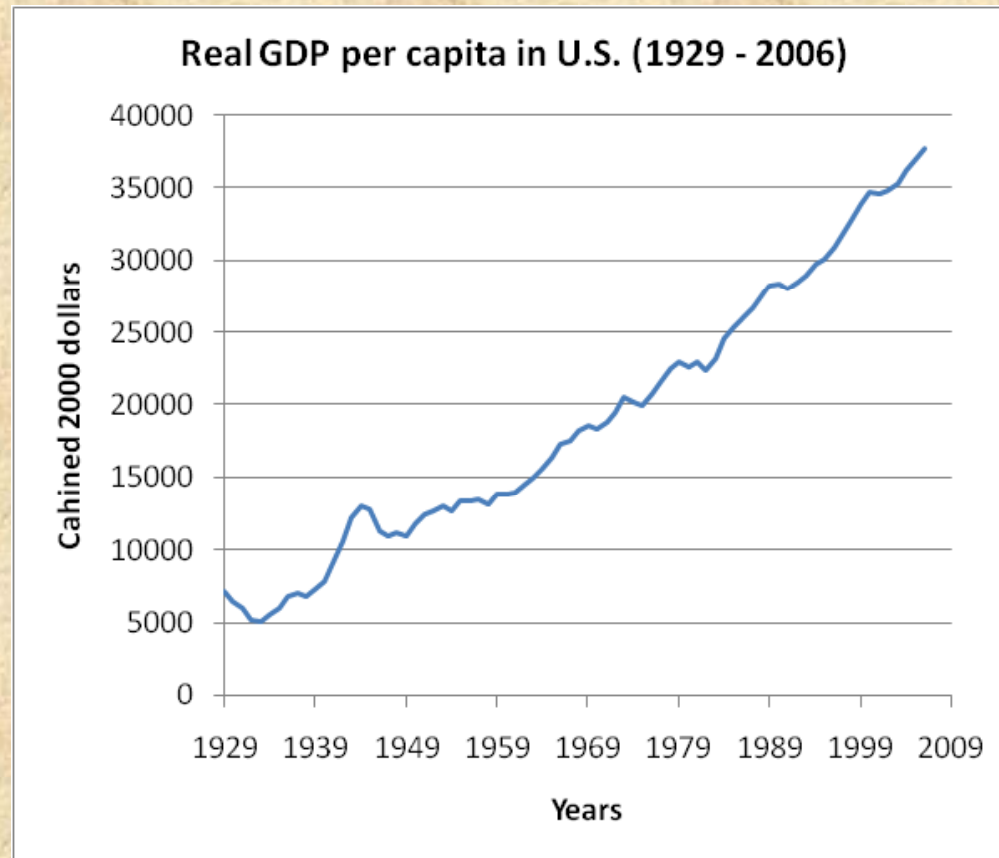
1. Why some countries are poor while others are rich?

Country	GDP per Capita, 2000
Congo, Dem. Rep.	246
Tanzania	515
Burundi	559
Ethiopia	678
Norway	28925
Singapore	31130
USA	35587
Luxemburg	47020

Background – Influenced by – **Contributions** – Impact - Critique

Two Important Questions

2. Will the growth in standard of living continue forever?



Background – Influenced by – **Contributions** – Impact - Critique

Contribution

- Solow growth model helps us to start answering those questions.

The Solow Model

- Output: $Y_t = A_t K_t^\theta L_t^{1-\theta}$, $0 < \theta < 1$
- Capital: $K_{t+1} = K_t(1 - \delta) + I_t$
- Saving and Investment: $S_t = I_t = sY_t$
- Population: $L_{t+1} = (1 + n)L_t$

The Solow Model

Output per worker:

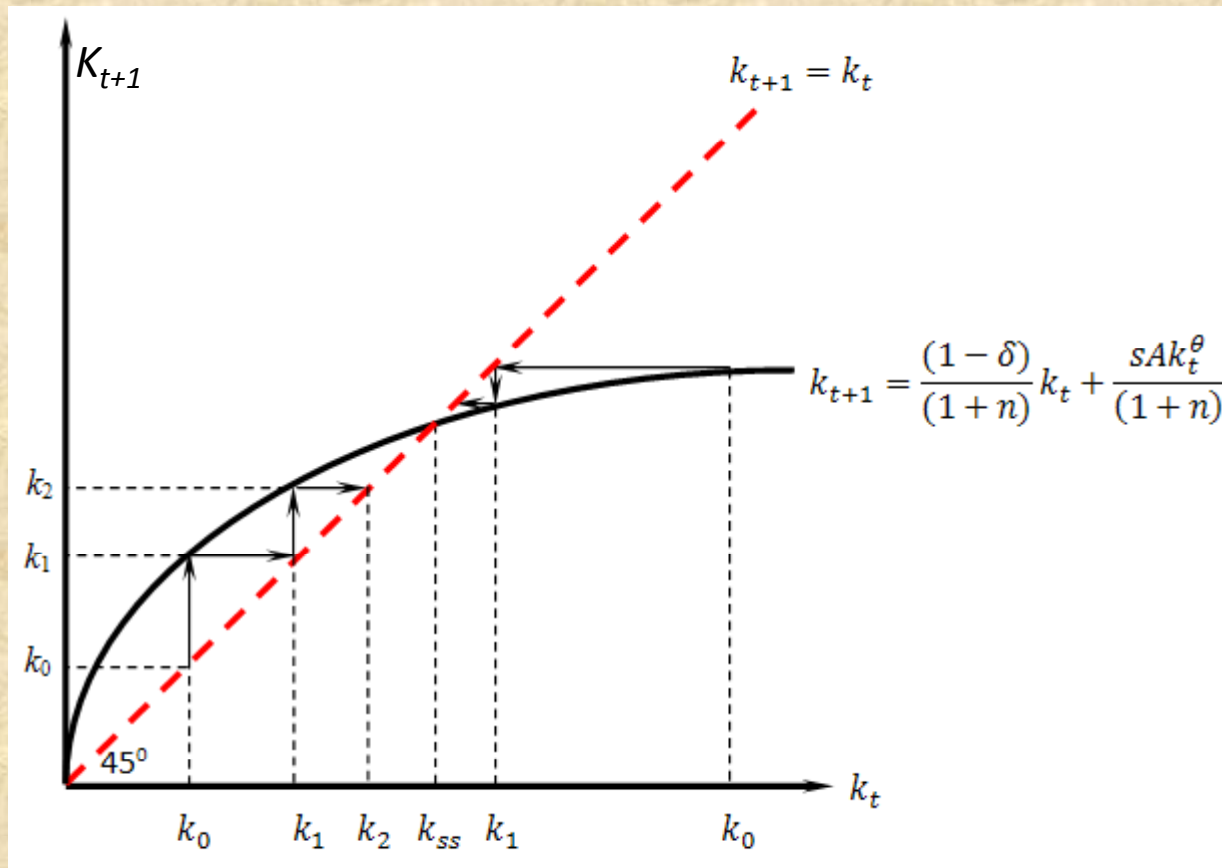
$$y_t = \frac{Y_t}{L_t} = \frac{A_t K_t^\theta L_t^{1-\theta}}{L_t} = A_t \left(\frac{K_t}{L_t} \right)^\theta = A_t k_t^\theta$$

Law of motion of capital per worker:

$$\begin{aligned} \frac{K_{t+1}}{L_{t+1}} &= \frac{K_t (1 - \delta)}{L_{t+1}} + \frac{I_t}{L_{t+1}} \\ k_{t+1} &= \frac{K_t (1 - \delta)}{L_t (1 + n)} + \frac{sY_t}{L_t (1 + n)} \\ k_{t+1} &= \frac{k_t (1 - \delta)}{1 + n} + \frac{sA_t k_t^\theta}{1 + n} \end{aligned}$$

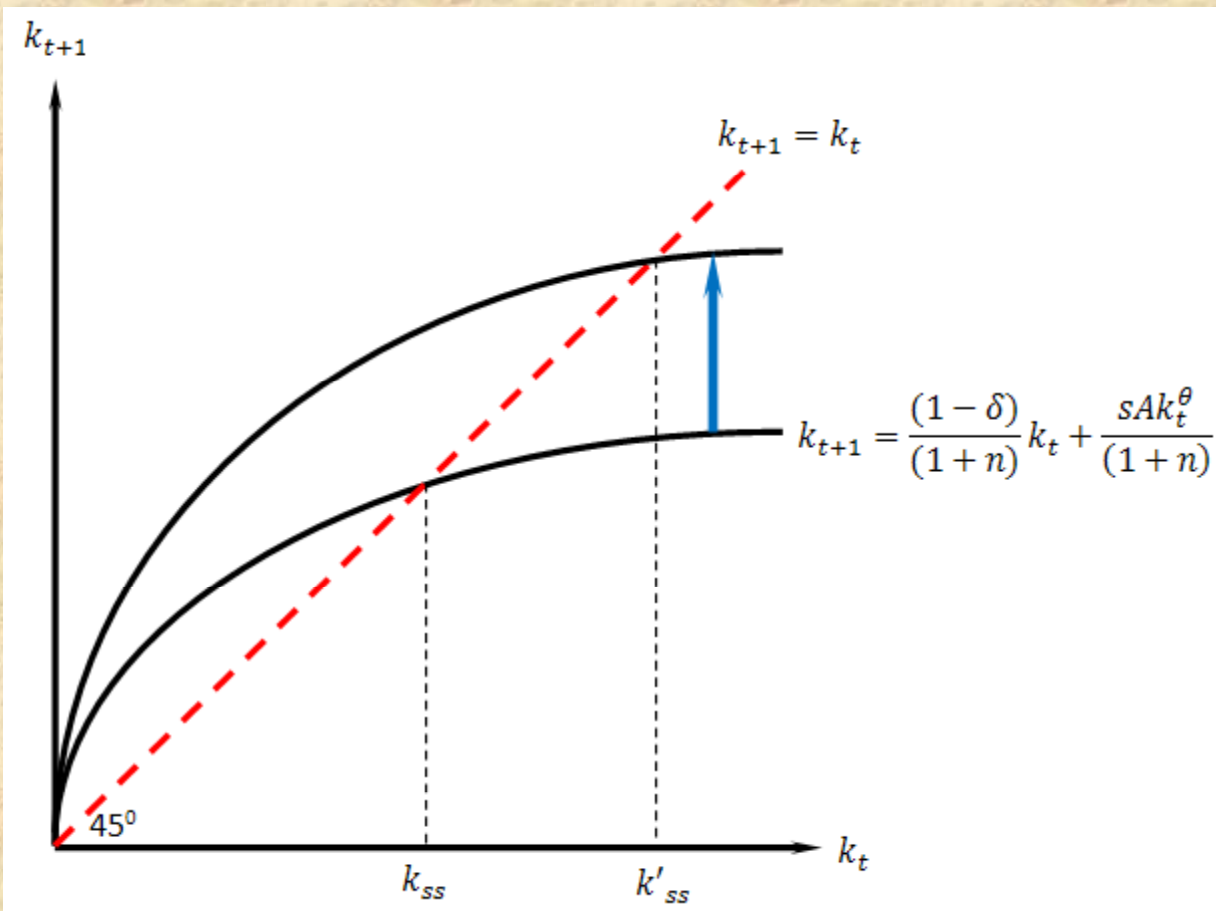
The Solow Model

If n , s , and A are fixed, then the model converges to steady state.



The Solow Model

How can capital per worker **permanently** increase in this model?



- 1. $s \uparrow$
- 2. $n \downarrow$
- 3. $A \uparrow$

The Solow Model

- Back to the **two most important questions in economics.**
- According to the Solow model:
 1. Why some countries are poor while others are rich?
 - Because of differences in n , s , and A .
 2. Will the growth in standard of living continue forever?
 - It depends on growth of A .

Background – Influenced by – Contributions – **Impact** - Critique

- Solow demonstrated that sustained growth in standards of living is possible only if **productivity** grows.
- As a result, modern research on growth and development, attempts to develop a theory of productivity (A).
 - What is productivity?
 - How can we measure productivity?
 - What makes it grow over time?
 - What is the effect of government policies on productivity?

Critique

- Saving (and investment) rate is **exogenous** in the Solow model.
- In his defense, the conclusions of the model still remain, even in a more complicated Ramsey model, in which saving and investment are **endogenous**.

Questions

1. Why are some countries rich and others are poor, according to the Solow model?
2. Will the growth in standard of living continue forever?
3. Can persistent growth be achieved through higher saving rate?
4. What is the next step we need to make in order to understand growth?