Economic Growth Models and Inequality

Prof. Goldstein

Economic Demography

Econ/Demog c175

Week 3: Lecture B

Spring 2017

UC Berkeley

Today's agenda

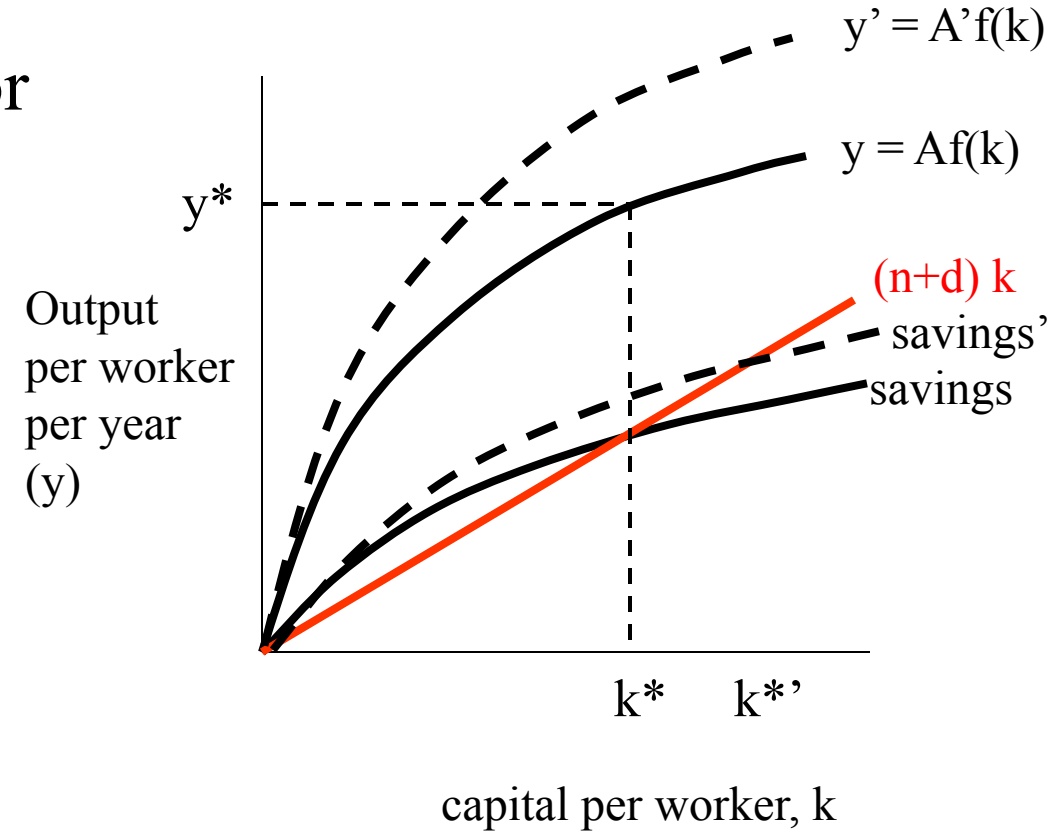
- Solow cont.
  - Technology
  - Income Shares
- Piketty and Inequality
  - Cobb-Douglas and Beyond
  - Quantitative impact?

Solow and Technology Improvement

- Let's include a factor "A" for technology
- Y = A f(K, L)

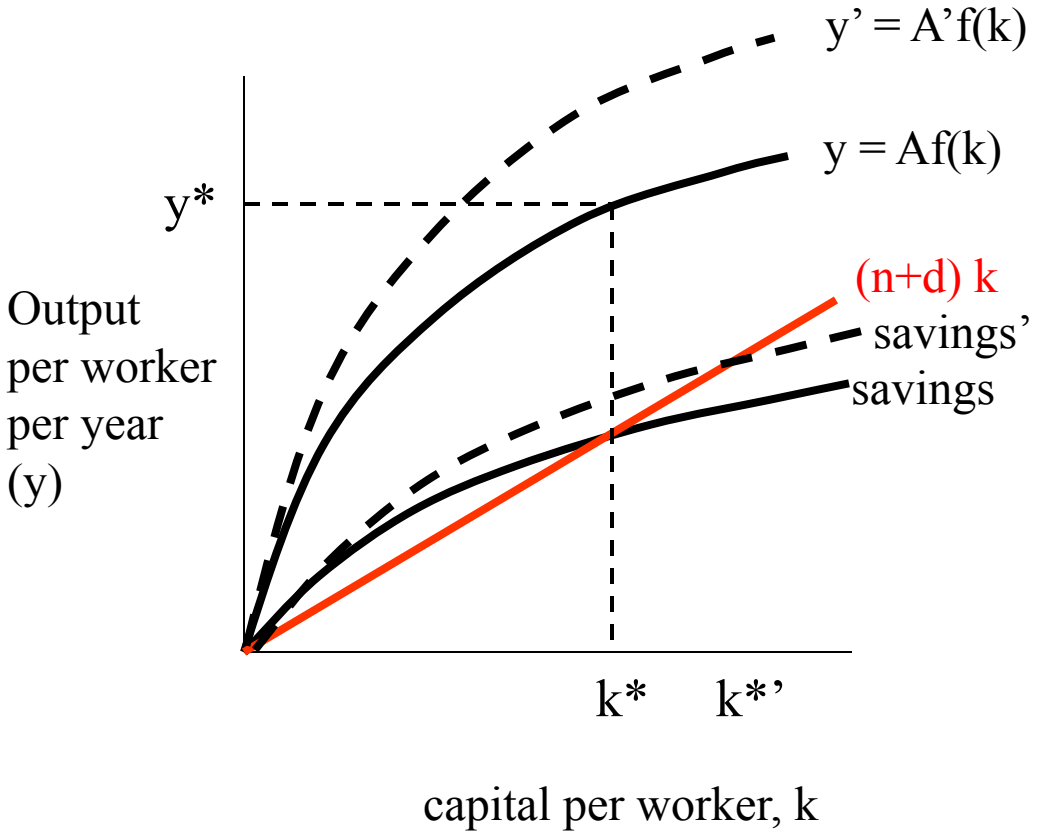
Constant returns to scale →

- y = Y/L
  = (A/L) f(K,L)
  = A f(K/L, L/L)
  = A f(k, 1)
- So y increases with A



Is technology effect permanent?

- Do we stay at k*'?
- Why don't we slip back, like Malthus?
- Solow ratchet vs. Malthus gerbil in a wheel



Technology effects: a two-step

First, we have effect of higher productivity with original amount of capital

$$y(k^*) \rightarrow y'(k^*)$$

Second, we have effect of capital deepening

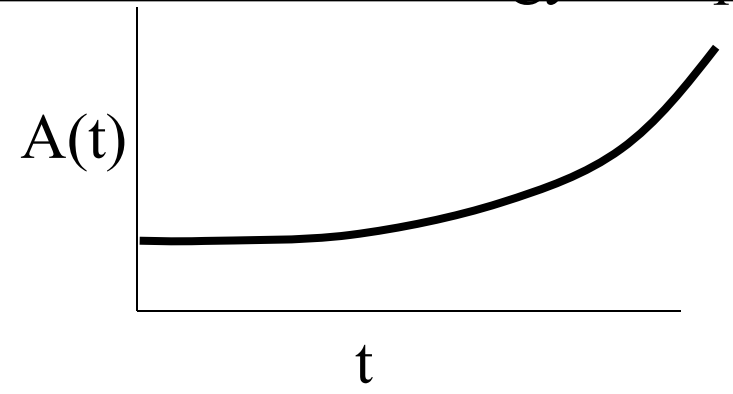
$$k^* \rightarrow k^{*\prime}$$

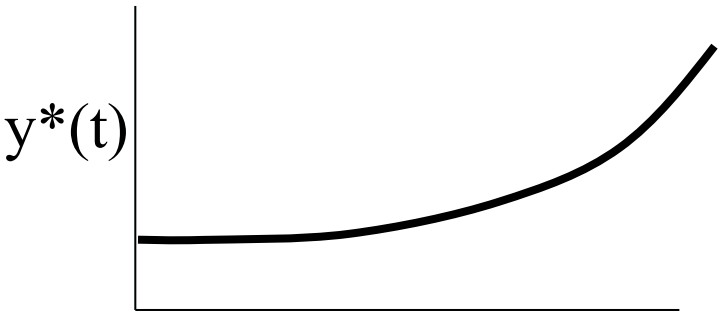
[Can see in app – in Lab]

Solow technology "ratchets"

- Each improvement gives us a new equilibrium, not just temporary
- Different from Malthus
  - Population ate away any improvement
  - Need more *k* but can support it with higher *y*

Per capita output *y* increases at same rate as technology *A* improves





So what does Solow explain?

- Without tech change, neo-classical growth gives us a way for population to grow without hurting income.
- → Population grows at rate *n*; Economy grows at rate *n*; per capita output constant

So what does Solow explain?

- Without tech change, neo-classical growth gives us a way for population to grow without hurting income.
- → Population grows at rate *n*; Economy grows at rate *n*; per capita output constant

- (This is the answer to the GREEN iclicker question we had on Tuesday)

So what does Solow explain? (cont.)

- *With* tech change, neo-classical growth gives us a way for population to grow and income to grow
- Say $A(t) = A_0 e^{g t}$
- → Population N grows at rate n;
- → Economy Y grows at rate $n + g$;
- → per capita output y grows at rate g

What doesn't Solow explain?

Exogenous factors:

- Technology
- Population
- (Also, savings rate *s*)

A question to think about

If we make population endogenous to Solow model, then might technology change have lead to acceleration of population growth?

Growth and Inequality

Piketty's argument

Stylized fact #1: Inequality's fall and rise

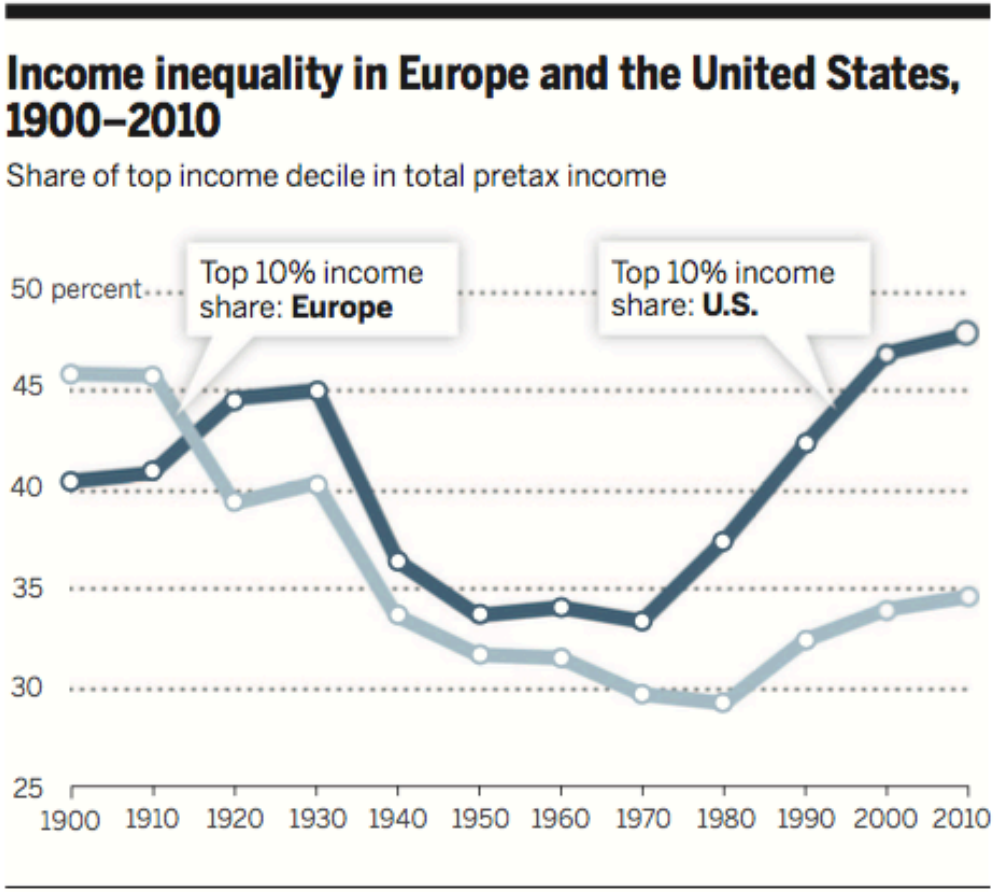


Fig. 1. Income inequality in Europe and the United States, 1900 to 2010.

Piketty & Saez reading

Stylized fact #2
Growth's rise and fall

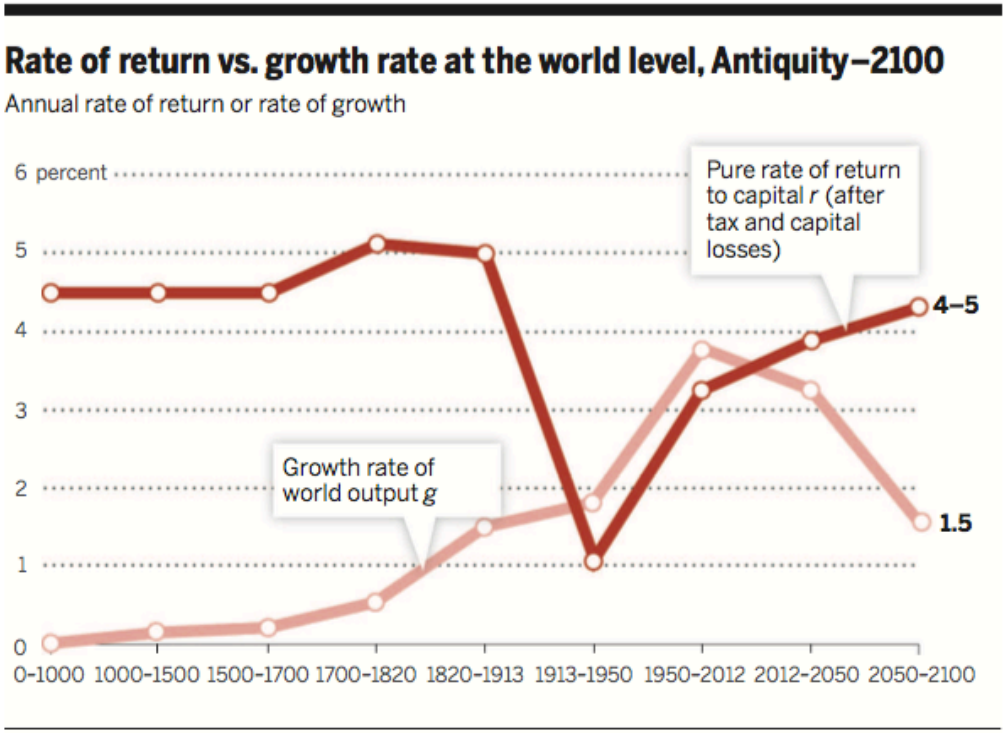


Fig. 4. Rate of return versus growth rate at the global level, from Antiquity until 2100. The

Piketty's capital idea

- Maybe mechanism is that lower growth increases capital per worker *k*
  (via Solow effect)

- And maybe more capital per worker increases income inequality?
  (How could this be?)

Piketty's argument

1. Slower growth → more capital per person (The neo-classical result)
2. More capital per person increases capital share of the economy (next)
3. Capital income more unequally distributed than labor income (right away)

QED: lower growth increases income inequality

Piketty 3. Income from capital is much more unequal than labor income

Table 1:
Piketty's estimates of labor and asset income received by the top decile for various inequality regimes with our estimate of the effect on total income of a unit increase in the capital/income ratio β

	Low inequality (Scandinavia, 1970s)	Medium inequality (Europe, 2010)	High inequality (US 2010, Europe 1910)	Very high inequality (US 2030?)
Labor income (H_l)	20%	25%	35%	45%
Asset income (H_k)	50%	60%	70%	90%
Total income (H_{l+k})	25%	35%	50%	60%
Effect of β increase ($dH_{l+k}/d\beta$)	1.50%	1.75%	1.75%	2.25%

Note: For example, if β were to increase by 2.0 from a 'low inequality' baseline, then the top decile share of income (H_{l+k}) would increase from 25% to 28% ($2.0 \times 1.50\%$). The first three lines of this table are from Piketty (p. 247-249). The derivative is our calculation based on change in weighted average of top decile share of labor earnings and capital earnings, assuming new capital earnings are perfectly correlated with existing capital earnings.

Source: Goldstein & Lee (2014)

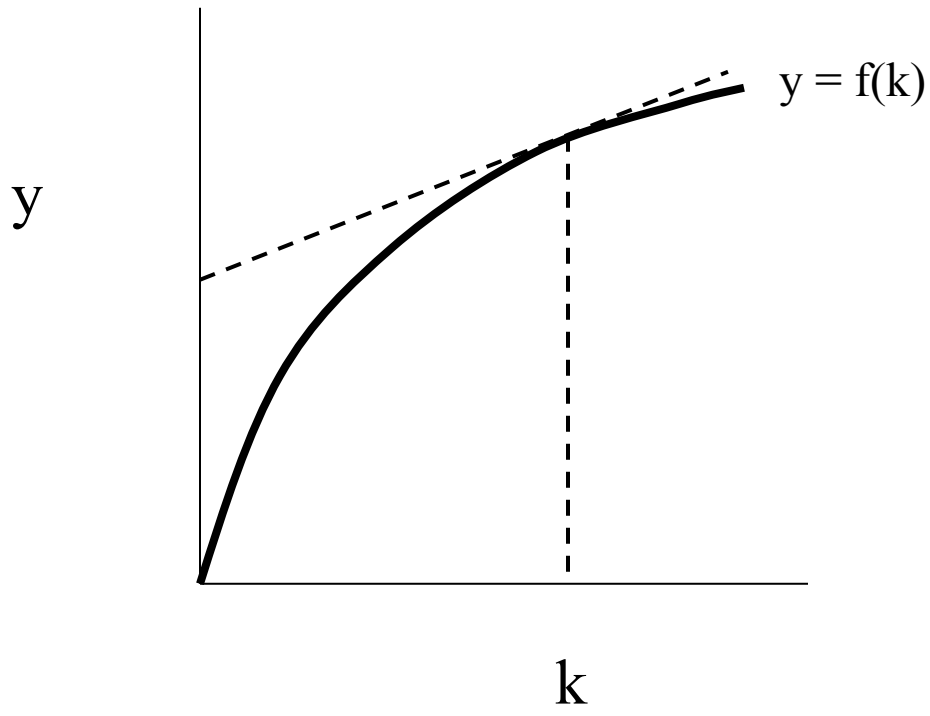
(Back to Piketty 2)
Some accounting

- $Y = Y_l + Y_k$
- Assuming perfectly competitive markets
  $Y_k = \text{MP}(K) * K$
  and
  $y_k = \text{MP}(k) * k$
- What are Y_l and y_l?

Marginal product

- Answers the question: if we increase a input factor, how much does output increase
- The slope of the production function (a.k.a. the derivative)

The marginal product of (k)apital = the slope of the production function



To do:
Sketch how MP(k) changes with k.

Does it go up, down, stay constant?

Does this remind you of anything in Malthus?

Distribution of income

In competitive economy, capital and labor each receives its marginal product:

Wage per person = mp(L)

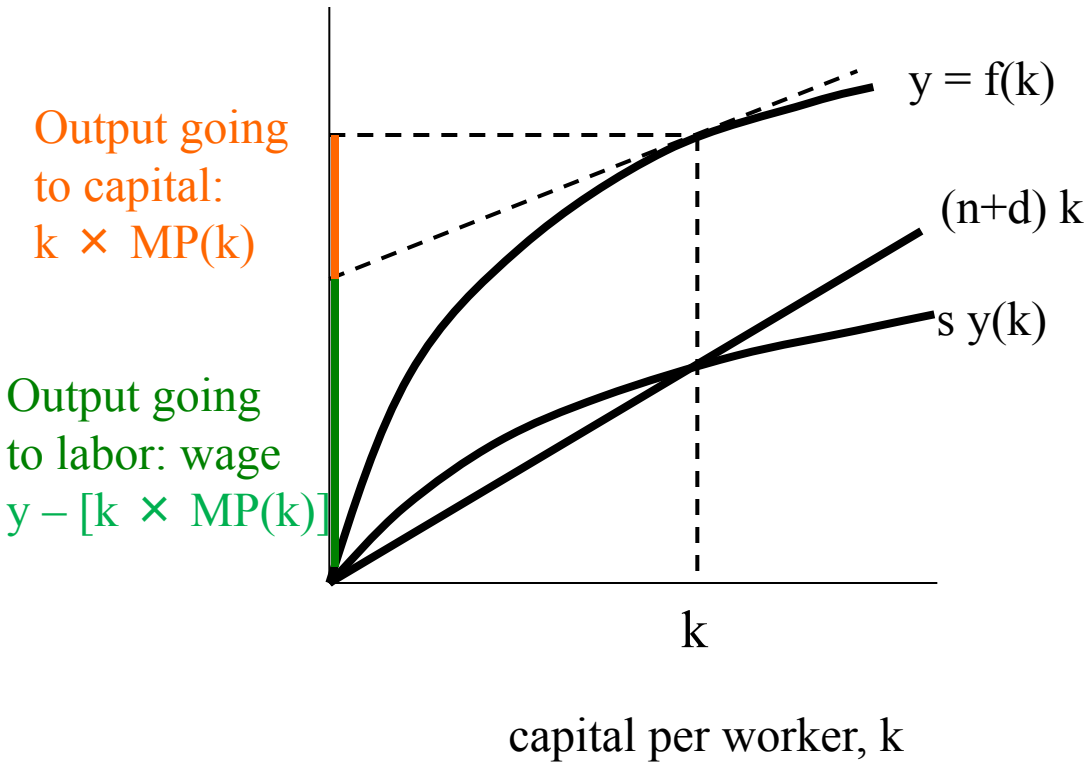
Return on capital = mp(K) = $f'(k)$

Per capita output: $y = f(k)$.

Of this, return on capital = $k \times mp(K) = k \times f'(k)$

So, wages = $f(k) - k \times f'(k)$

If population growth falls, output increases, wages increase, and return on capital falls. (cf. Piketty)



Does capital intensification increase capital's share of income

- Yes, because there's more capital
- No, because rate of return on capital goes down
- Who's right?

Share of income from capital

$$\text{Share}_{\text{capital}} = \frac{MP(y) * k}{y}$$

Cobb-Douglas: capital intensification cancels out

- With Cobb-Douglas: $y = k^a$
- We calculate MP
  $MP(k) = dy/dk = a\ k^{a-1}$
- We then substitute into
  $Share_{capital} = MP(k) * k / y$
  $= (a\ k^{a-1}) * k / k^a = a$
- So capital intensification exactly balanced by diminishing marginal returns. Share of national income from capital a constant, a

Let's try: what is capital share? (If we have time)

- MP(k) = $\alpha\, k^{\alpha-1}$
- y = k^{α}
- *Capital share* = $\frac{MP(k) * k}{y}$

- West:
  Let alpha = .3 & k = 1
- East:
  Let alpha = .3 & k = 2

2. But what if MP(k) declines more slowly?

- Can still have diminishing marginal returns
- But now increase in capital won't be fully offset by declines in MP(k)
- *Result is increasing share of capital.*
- This is what Piketty highlights as possible.
- Automation and robotization likely to be this way, he argues.

Piketty's argument

1. Slower growth → more capital per person (The neo-classical result)
2. More capital per person increases capital share of the economy (next)
3. Capital income more unequally distributed than labor income

QED: lower growth increases income inequality

Dramatic reading?

- Piketty and Saez p. 841

Conclusions

- Neo-classical growth retells the Malthusian story of an equilibrium around a constant standard of living.
- Good news :
  - Steady population growth without worsening wages (not possible in Malthus)
  - Technological change creates permanent improvement (not transitory like Malthus)
- Bad news :
  - More capital (e.g., “foreign aid”) won’t change steady state output
  - Faster population growth implies lower income (unless forego consumption and keep savings up)
  - Key to long-term per capita growth is technology, not savings.

Conclusions of application of Solow model to Inequality

- Slower population growth (and also economic growth in general) increases capital's share of the economy
- More capital → more inequality (according to Piketty)

For next time

- Understanding technological change
- Are we doomed? (Running out of resources)