Wage Structure and Inequality: Third Lecture

LABOR ECONOMICS (ECON 385)

BEN VAN KAMMEN, PHD

Skill biased technological change (SBTC)

- Skill biased technological change (SBTC) is an explanation that holds up exceedingly well for analyzing and explaining changes in inequality over time.
- Say that the economy has a production function for the aggregate of its output (Y), and it uses two inputs, high skill workers (H) and low skill workers (L).
- Skill premium rises because technology increases the relative demand for H and the relative supply of H cannot keep up.
  - This increases inequality.

SBTC (continued)

- Production is according to the (fairly general) functional form known as CES (constant elasticity of substitution):

$$Y = [(A_H H)^{\frac{\sigma-1}{\sigma}} + (A_L L)^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$$

Where A_L and A_L capture the technology that augments the two inputs, H and L. Sigma (σ) is the elasticity of substitution, defined in the optional appendix.

- The elasticity of substitution determines how substitutable H and L are.
  - E.g., if $\sigma = 0$, they are used in fixed proportion, i.e., perfect complements.
  - $\sigma \to \infty$ implies perfect substitutes.
  - $\sigma = 1$ is the Cobb-Douglas production function.

SBTC (continued)

- The elasticity of substitution is important to the theory of skill biased technological change (SBTC) espoused here. If $\sigma > 1$ high and low skill labor are net substitutes in the following sense:

  that technological change that augments high skill labor will decrease the ratio of low skill-high skill demand, i.e., increase the relative demand for high skill labor.

SBTC (continued)

- It can be shown that when costs are minimized, the natural log of the RTS equals the natural log of the wage ratio, $\frac{w_H}{w_L}$. So,

$$\ln\left(\frac{w_H}{w_L}\right) = \frac{\sigma - 1}{\sigma}\ln\left(\frac{A_H}{A_L}\right) - \frac{1}{\sigma}\ln\left(\frac{H}{L}\right)$$

- This condition embodies the two possibilities for the rising skill premium observed over time . . .

Sources of the rising skill premium

- A shift in the relative demand for skilled workers resulting from skill biased technological change is shown by:

$$\frac{\partial \ln\left(\frac{w_H}{w_L}\right)}{\partial \ln\left(\frac{A_H}{A_L}\right)} = \frac{\sigma - 1}{\sigma} > 0 \text{ if } H, L \text{ are net substitutes}$$

  - Which is to say the wage ratio increases when the demand shifts out.

- A shift in the supply of high skill workers is shown by:

$$\frac{\partial \ln\left(\frac{w_H}{w_L}\right)}{\partial \ln\left(\frac{H}{L}\right)} = -\frac{1}{\sigma} < 0 \text{ if } H, L \text{ are net substitutes}$$

  - Which is to say the wage ratio decreases when the (relative) supply shifts out.

Measuring the effects of relative demand for and supply of skill

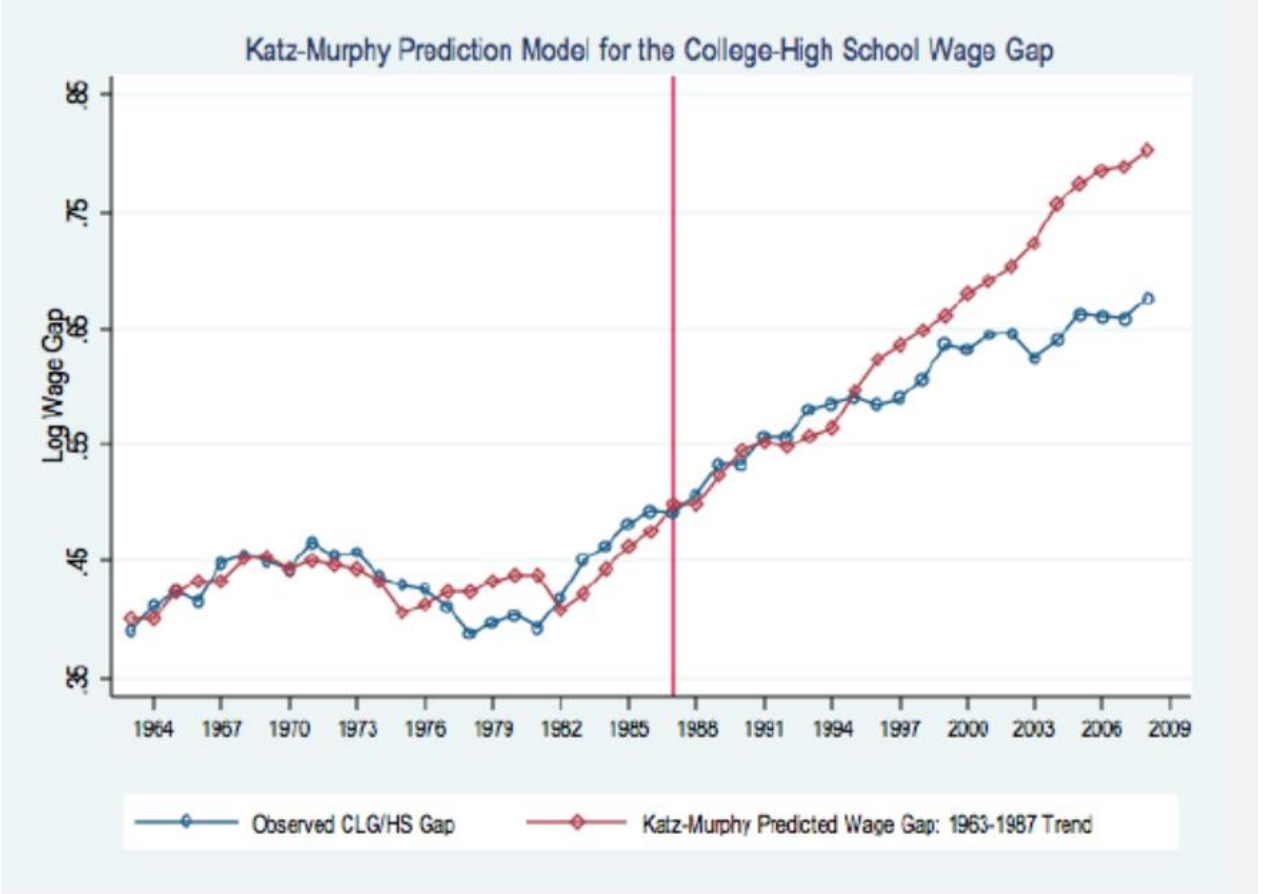
- The cost minimization condition is almost directly estimable from data if you can observe the wages for the two different groups and the relative size of the two groups in the labor force.*
- Katz's and Murphy's estimate of the annual rate of increase in demand for high skill labor is 3.3%, and their estimate of the elasticity of substitution is 1.41, putting it in the range for substitutes.

*Lawrence Katz and Kevin M. Murphy estimated the relationship in "Changes in Relative Wages, 1963-1987: Supply and Demand Factors." 1992. *Quarterly Journal of Economics*, Vol. 107, No. 1: 35-78.

Predicting the future trend in inequality

- Applying the K-M estimates to construct an out of sample prediction for the period after 1987, using observed ratios of college graduates to non-graduates yields the comparison on the next slide (the red line is the prediction of their model).
- The K-M prediction actually overestimates the degree of wage inequality observed in the post 1987 period; the observed college premium was lower than predicted.

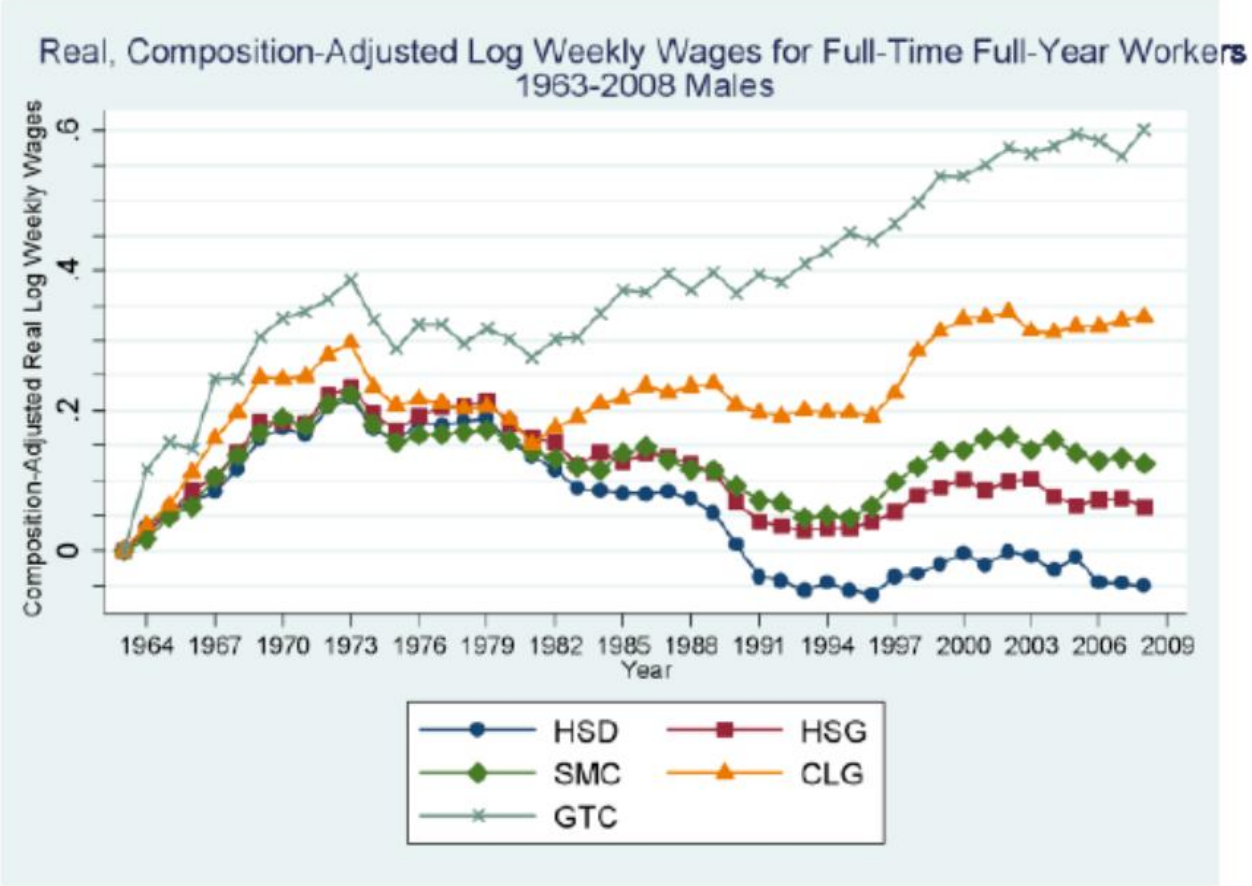
SBTC overestimated inequality increases during the 1990s



Shortcomings of SBTC

- Technological progress is supposed to increase the real wages of low skill workers (easy to see why increasing A_L would increase demand for *L*). But also increasing A_H increases output and demand for *L* as well as *H*.
- However the real wages for low education workers declined during the period.

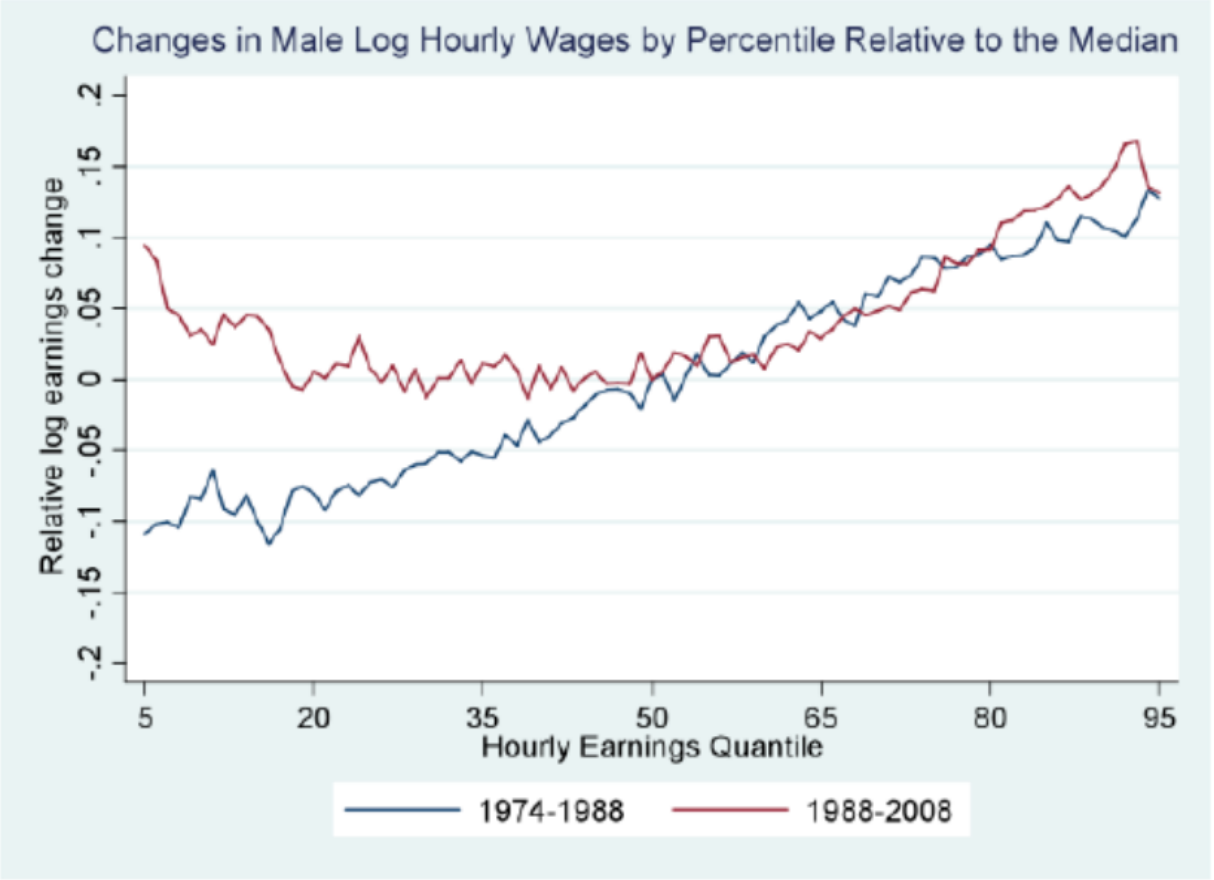
Decrease in real wages of low skilled workers



Shortcomings of SBTC (continued)

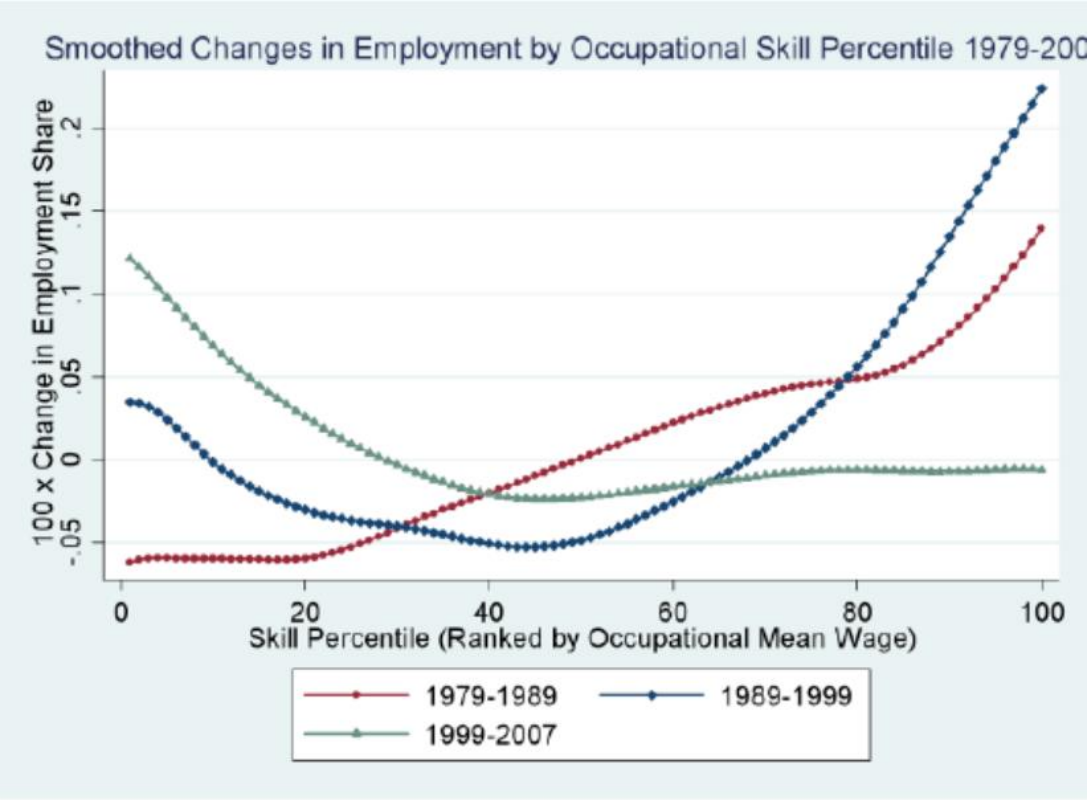
- The change in wage distribution (especially since 1990) has not been monotonically increasing in skill.
- This model (which has only two skill levels) predicts that more skilled will always benefit from SBTC.
- The “middle skill” occupations experienced less wage growth than the low and high groups did.

“Low” did better than “middle” skill during the 1988-2008 period



Shortcomings of SBTC (continued)

- The same is visible if you look at growth of employment by skill level (approximated by average wage in your occupation).



Augmenting the SBTC model

There are two theoretical directions that one could go, based on the promise and the shortcomings of the SBTC model.

- Conclude that some other explanation for structural wage changes, e.g., institutional changes to unionization, international trade, or the minimum wage propelled the trend in the last 20 years.
  - All of these are worthwhile influences that I do not have time to elaborate here.
- Augment the SBTC model to incorporate more than two skill groups and model the assignment of tasks in the production function among the groups.
  - This augmentation is too lengthy to discuss in full here, but the explanation is available in the David Autor and Daron Acemoglu outline, "Skills, Tasks, and Technologies."*
  - The implication of Autor's and Acemoglu's model can address most or all of the shortcomings of the basic SBTC model, but it is a new development that has not had much time to test predictions (yet).

*http://www.oecd.org/els/emp/45261203.pdf

Intergenerational transmission of inequality ("income mobility")

- Inequality across generations is related to how individuals are endowed in childhood with unequal human capital investments by their parents.
  - Specifically parents with a lot of income invest more in the human capital of their children. This can generate a positive intergenerational elasticity of the incomes of consecutive generations.
- Studies performed in the 1990s, with improved corrections for measurement error, have concluded that the correlation between parents' income and their children's incomes is between 0.3 and 0.4.
  - This suggests that income differences are fairly persistent across generations, but are also far from deterministic of the performance of children.
- Surely a lot more could be said about fertility, income, and policy issues related to this subject, but like many other peripheral topics in this class, the further exploration is left to the interested student.

Conclusion

- Studying the income distribution is the culmination of everything you learn in this class.
- It summarizes the outcomes of all labor market transaction and is affected by every other phenomenon we study here:
  - Technology,
  - Education and human capital,
  - Marriage and household composition,
  - Search and matching of workers to jobs,
  - Laws and institutions.

Conclusion

- These are just the most prominent drivers of labor market outcomes.
- I have attempted to explain how agents make these decisions and to suggest ways that students can indulge topics of interest with further study.
- Even students that do not pursue Labor Economics further, academically, ought to benefit from insights into:
  - Planning one's career,
  - Strategy for managing human resources in a professional setting, and
  - Understanding current events with labor market implications.

Elasticity of substitution (for hardcore micro lovers only)

$$MP_H \equiv \frac{\partial Y}{\partial H} = [(A_H H)^{\frac{\sigma-1}{\sigma}} + (A_L L)^{\frac{\sigma-1}{\sigma}}]^{\frac{1}{\sigma-1}} (A_H H)^{\frac{\sigma-1}{\sigma}} H^{-1}$$

$$MP_L \equiv \frac{\partial Y}{\partial L} = [(A_H H)^{\frac{\sigma-1}{\sigma}} + (A_L L)^{\frac{\sigma-1}{\sigma}}]^{\frac{1}{\sigma-1}} (A_L L)^{\frac{\sigma-1}{\sigma}} L^{-1}$$

$$RTS \equiv \frac{MP_H}{MP_L} = \left(\frac{A_H}{A_L}\right)^{\frac{\sigma-1}{\sigma}} \left(\frac{L}{H}\right)^{\frac{1}{\sigma}} \rightarrow \ln RTS = \frac{\sigma-1}{\sigma} \ln\left(\frac{A_H}{A_L}\right) + \frac{1}{\sigma} \ln\left(\frac{L}{H}\right)$$

$$\Leftrightarrow \ln\left(\frac{L}{H}\right) = \sigma \ln RTS + (1-\sigma) \ln\left(\frac{A_H}{A_L}\right)$$

$$\frac{\partial \ln\left(\frac{L}{H}\right)}{\partial \ln RTS} = \frac{\%\,\Delta \text{ in } input\ ratio}{\%\,\Delta\ RTS} \equiv Elasticity\ of\ Subst. = \sigma$$

Back.

Net substitutes in production

$$\frac{\partial \ln\left(\frac{L}{H}\right)}{\partial \ln\left(\frac{A_H}{A_L}\right)} = (1-\sigma) < 0 \text{ if net substitutes}$$

- This will hold if σ is greater than 1.

Back.

Only *relative* wages are supposed to go down with technological progress

- Not the actual wage level!

$$\frac{\partial w_L}{\partial A_H} = \frac{1}{\sigma A_H}(A_H H)^{\frac{\sigma-1}{\sigma}}[(A_H H)^{\frac{\sigma-1}{\sigma}} + (A_L L)^{\frac{\sigma-1}{\sigma}}]^{\frac{2-\sigma}{\sigma-1}}(A_L L)^{\frac{\sigma-1}{\sigma}} L^{-1} > 0$$

Back.