Setup

- There are two goods (1 and 2) and two factors (skilled and unskilled labor).
- Good i is produced with the following unit cost function (CRS):

$$c_i(w_s, w_u)/\omega_i.$$

  - We introduce productivity ω_i for future use.
- Good 1 is more skill intensive.

Profit maximization

- Profit maximization requires

$$p_i \leq c_i(w_s, w_u)/\omega_i$$

with equality if production is positive.
- Suppose both goods are produced in equilibrium. Then

$$p_i \omega_i = c_i(w_s, w_u)$$

- What happens to wages if p or ω change?

Jones' algebra

- Totally differentiate the zero-profit condition wrt $\ln p$, $\ln \omega$ and $\ln w$:

$$d \ln p_i + d \ln \omega_i = \frac{\partial c_i}{\partial w_s} \frac{w_s}{c_i} d \ln w_s + \frac{\partial c_i}{\partial w_u} \frac{w_u}{c_i} d \ln w_u$$

- But we know that

$$\frac{\partial c_i}{\partial w_n} = a_n,$$

  the unit input requirement.

- So

$$d \ln p_i + d \ln \omega_i = \theta_{is} d \ln w_s + \theta_{iu} d \ln w_u$$

  where θ_{is} is the share of skilled labor in the cost of producing good i, and $\theta_{iu} = 1 - \theta_{is}$ is the share of unskilled labor.

Jones' algebra

- (Denote $d \ln x$ by $\hat{x}$.)
- Solve for wage changes:

$$\hat{w}_s = \hat{p}_1 + \hat{\omega}_1 + \frac{\theta_{1u}}{\theta_{1s} - \theta_{2s}} (\hat{p}_1 - \hat{p}_2 + \hat{\omega}_1 - \hat{\omega}_2)$$
$$\hat{w}_u = \hat{p}_2 + \hat{\omega}_2 - \frac{\theta_{2s}}{\theta_{1s} - \theta_{2s}} (\hat{p}_1 - \hat{p}_2 + \hat{\omega}_1 - \hat{\omega}_2)$$

- First, assume away productivity changes, $\hat{\omega} \equiv 0$.

The Stolper–Samuelson theorem

- Suppose that the relative price of the skill-intensive good rises,

$$\hat{p}_1 - \hat{p}_2 > 0.$$

- This would happen in a skill-abundant country if it opens up to trade.
- Then

$$\hat{w}_s > \hat{p}_1 > \hat{p}_2 > \hat{w}_u.$$

  - Skilled wages increase *more than proportionally*.
    - real skilled wage increases
  - Unskilled wages decline relative to both product prices.
    - real unskilled wage decreases

Implications for inequality

- Because skill wages were higher to begin with, their further increase raises inequality:

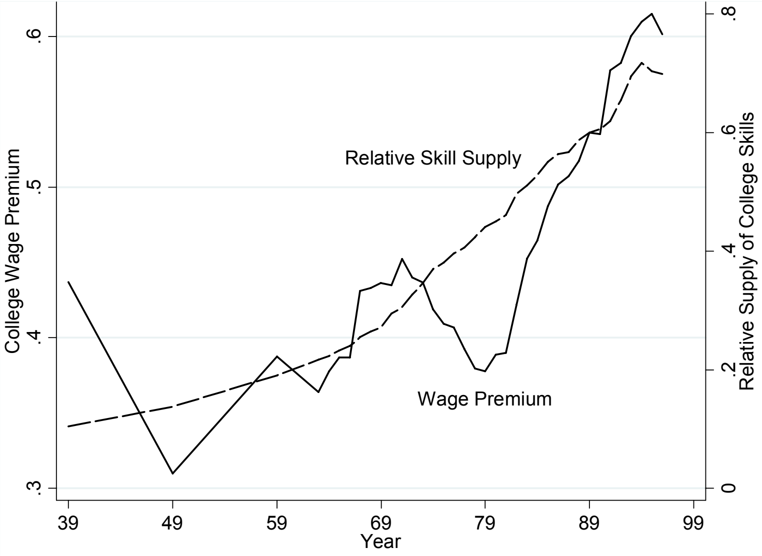
$$\hat{w}_s > \hat{w}_u.$$

- In fact, unskilled workers will *lose* from globalization.
- Any trade opening has big distributional consequences.

Evidence

- This prediction is roughly in line with wage developments in the U.S.
- China and other low-wage ($\approx$ unskilled-abundant) countries started increasing their trade with the U.S. in the 80s.
- Coinciding with large changes in the skill premium.
- This raises two questions:
  1. Quantitatively what fraction of the rise in inequalities is due to trade?
  2. What happened in the low-wage countries?

The skill premium and the supply of skilled labor



Many-good case

Many-good case

- As usual, the many-good case allows for weaker statements only.
- Suppose there are n sectors and n factors.
- Profit maximization in sector i:

$$p_i \omega_i = c_i(w_1, ..., w_n)$$

- Totally differentiating:

$$\hat{p}_i + \hat{\omega}_i = \sum_n \theta_{in} \hat{w}_n$$

Stolper–Samuelson with many factors

- Suppose $\hat{p}_1 > 0$ and $\hat{p}_i = 0$ for all $i > 1$.
- It then has to be the case that

$$\tilde{w}_n > \tilde{p}_1$$

  for some n, and

$$\tilde{w}_k < 0$$

  for some k.
- Someone wins, someone loses.
- (The math of the proof is identical to that of the Rybczynski theorem.)
- Intuition:
  1. It's clear that some factor has to become more expensive, $\tilde{w}_n > 0$.
  2. To maintain zero profits in sectors without a price change, some factor has to become cheaper, $\tilde{w}_k < 0$.
  3. Because some factors have become cheaper, the gaining factor can appreciate even more.

The flip side

- In the unskilled-abundant country, the opposite relative wage pattern should emerge.
- For these countries, skill-intensive goods were relatively expensive, so after opening

$$\hat{p}_1 - \hat{p}_2 < 0.$$

- Then

$$\hat{w}_s < \hat{p}_1 < \hat{p}_2 < \hat{w}_u.$$

- That is, in these countries, inequality should have *declined*.

Evidence from other countries

- Goldberg and Pavcnik (2007, JEL) survey the empirical evidence from developing countries.
- In most cases, inequality increased in parallel with globalization.
- This contradicts the Stolper–Samuelson theorem.
- (Or stronger forces were also at play.)

Globalization in some developing countries

	Trade Liberalization			
	Average Tariff		Average NTB	
	Before	After	Before	After
Argentina	45	12	n.a.	declined
Brazil	58.8	14.4	n.a.	declined
Chile	105	10	n.a.	declined
Colombia	50	13	72.2	1.1
Hong Kong	n.a.	n.a.	n.a.	n.a.
India	117	39	82	17
Mexico	23.5	11	92	23.2

Skill-biased technical change

Skill-biased technical change

- Technical change may be such a "stronger force".
- Now suppose that productivities change, but prices don't.
- (In GE, prices would of course react to productivity changes. However, these would just add to the changes discussed below.)
- Solve for wage changes:

$$\hat{w}_s = \hat{\omega}_1 + \frac{\theta_{1u}}{\theta_{1s} - \theta_{2s}}(\hat{\omega}_1 - \hat{\omega}_2)$$
$$\hat{w}_u = \hat{\omega}_2 - \frac{\theta_{2s}}{\theta_{1s} - \theta_{2s}}(\hat{\omega}_1 - \hat{\omega}_2)$$

- Change in inequality:

$$\hat{w}_s - \hat{w}_u = \frac{1}{\theta_{1s} - \theta_{2s}}(\hat{\omega}_1 - \hat{\omega}_2)$$

Skill-biased technical change

- Inequality increases if and only if productivity increases faster in the skill-intensive sector.
  - E.g., computers augment skilled labor, may even substitute unskilled labor.
- Unlike trade opening, this would have a uniform impact across all countries.

Evidence

- In *labor*, there is a whole literature about the effects of skill-biased technical change.
- Key authors: David Autor, Lawrence Katz, Daron Acemoglu, Alan Krueger, David Card.
- Below we look at some random examples of how to study these questions from *up close*.

Computers and wages

- Krueger (1993, QJE) uses microdata to estimate the effect of computer use on wages.
- He finds that those who use a computer at work earn about 15% more even controlling for

Computer usage and wages

Dependent variable: ln (hourly wage)

Independent Variable	October 1984 (1)	(2)	(3)	October 1989 (4)	(5)	(6)
Intercept	1.937 (0.005)	0.750 (0.023)	0.928 (0.026)	2.086 (0.006)	0.905 (0.024)	1.094 (0.026)
Uses computer at work (1=yes)	0.276 (0.010)	0.170 (0.008)	0.140 (0.008)	0.325 (0.009)	0.188 (0.008)	0.162 (0.008)
Years of education	---	0.069 (0.001)	0.048 (0.002)	---	0.075 (0.002)	0.055 (0.002)
Experience	---	0.027 (0.001)	0.025 (0.001)	---	0.027 (0.001)	0.025 (0.001)

Computers and wages?

- But are these results about computers?
- DiNardo and Pischke (1997, QJE) replicate Krueger's results.
- They then show that they also hold for those who work with *pencils*.

Replicating Krueger's results

Dependent Variable: Log Hourly Wage
(Standard Errors in Parentheses)

Independent variable	US 1984	US 1989	Germany 1979	Germany 1985/86	Germany 1991/92
Computer	0.170	0.188	0.112	0.157	0.171
	(0.008)	(0.008)	(0.010)	(0.007)	(0.006)
Years of schooling	0.069	0.075	0.073	0.064	0.072
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Experience	0.027	0.027	0.030	0.035	0.030
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Wages and other tools

Table 4:
OLS Regressions for the Effect of Different Tools
Dependent Variable: Log Hourly Wage
(Standard Errors in Parentheses)

Independent variable	Germany 1979	Germany 1985/86	Germany 1991/92
Occupation Indicators			
	No	No	No
			Tools entere
Computer	0.112	0.157	0.171
	(0.010)	(0.007)	(0.006)
Calculator	0.088	0.128	0.129
	(0.007)	(0.006)	(0.006)
Telephone	0.131	0.115	0.136
	(0.006)	(0.006)	(0.006)
Pen/Pencil	0.122	0.112	0.127
	(0.006)	(0.006)	(0.006)
Work while sitting	0.105	0.102	—
	(0.006)	(0.007)	
Hand tool	-0.117	-0.087	-0.092
(e.g. hammer)	(0.006)	(0.006)	(0.006)