14.581: International Trade
— Lecture 9 —
Heckscher-Ohlin Model and Inequality (Empirics II)

Plan for Today's Lecture

- "Regional Incidence" approaches to measuring the effects of Trade shocks.
  - Topalova (2010), Kovak (2013), Autor, Dorn and Hanson (2013)
- Trade and Wage Inequality
  - Introduction to Trade and Wage Inequality.
  - Stylized facts about recent changes in wage inequality.
  - Can Heckscher-Ohlin theory make sense of these changes?
    - Some uncomfortable facts from the perspective of the H-O interpretation.
    - Michaels (2008) within the US.
    - Other approaches.

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"Regional Incidence" of Trade Shocks

- Suppose a change in trade policy affects p (one nation-wide goods price vector). How does this affect welfare (ie, real income, here) in different regions of a country?
    - This has been an important topic at the intersection of the Trade and Development literatures
    - This is the question that Topalova (AEJ Applied, 2009) and Kovak (AER 2013) try to answer, with respect to India and Brazil, respectively.
    - Porto (JIE, 2005), among others, also looks at this question but not using local labor market approach (will discuss later).
    - Autor, Dorn and Hanson (AER, 2013) is closely related methodologically and looks at the impact of Chinese productivity improvements (and/or trade cost reductions) on US regions.

"Regional Incidence" of Trade Shocks

- Also, the Specific Factors model (often implicitly) has been an influential theoretical approach within which to attack this empirical question (and many other outcomes: unemployment, child labor, inequality, etc etc etc).
  - Topalova (2010): labor is intersectorally immobile and geographically immobile
  - Kovak (2013): labor is intersectorally immobile but geographically mobile
  - Autor, Dorn and Hanson (2013): assume regions are SOEs with different CAs (but logic similar to Topalova).

Topalova (2010)

- Topalova (2010) wants to evaluate the 1991 Indian Trade Liberalization by running a regression something like this:

$$y_t = \gamma \text{TradeReforms}_t + \varepsilon_t$$

- Here, y_t is (India-wide) the poverty rate, and TradeReforms_t might be a dummy for Post 1991.
- India is attractive here for many reasons:
  - India went through an important and controversial trade liberalization in 1991 (and later in the 1990s).
  - There are very good, long-running surveys of poverty, for which the micro data is available from 1983 onwards.
  - There are 400-600 districts, depending on the time period (will be useful).
- What are the two key endogeneity problems here?

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  - There are 400-600 districts, depending on the time period (will be useful).
- What are the two key endogeneity problems here?
  - Trade reforms endogenous. Why?
  - Other time trends/economic reforms.

Topalova (2010)

- So Topalova (2010) actually estimates the following regression on Indian districts:

$$y_{dt} = \alpha_d + \beta_t + \gamma \text{Tariff}_{dt} + \varepsilon_{dt}$$

- Here, y_{dt} is the district d poverty rate, and Tariff_{dt} is a measure of the the tariff impact on district d.
- Question 1: What does doing this at the district level buy us?
  - What do we give up?
  - Do we care?
  - How should we interpret estimate of γ?

Topalova (2010)

- Topalova (2010) estimates following regression on Indian districts:

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- Question 2: How to measure trade exposure?

- Tariff_{dt} is tariff exposure calculated as the district employment-weighted average of national industry-wise tariffs (using 1991 employment weights).
  - This is similar to a Bartik (1991) instrument: Bartik used national industry-level job growth interacted with local labor market (as labor demand shock to study labor supply questions). composition.
  - What are the identifying assumptions? Why might these be violated?
  - Also, what about non-traded goods? Share non-traded correlated with initial poverty.

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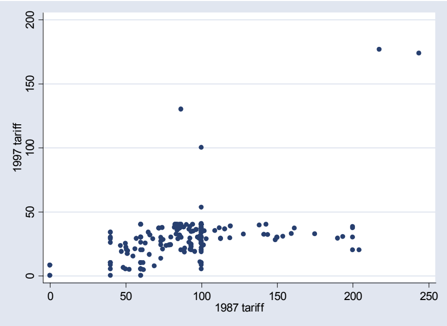
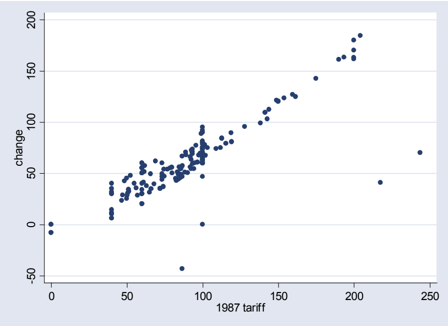
- Here, y_{dt} is the poverty rate, and Tariff_{dt} is a measure of the the tariff impact on district d.
- Question 2: How to measure trade exposure?
- Tariff_{dt} is tariff exposure calculated as the district employment-weighted average of national industry-wise tariffs.
- Because of concerns above, Topalova (2010) uses a (now standard) IV for tariffs:
  - In trade liberalization episodes, higher tariffs have "further to fall".
  - So a plausible instrument for tariff changes is pre-liberalization tariff levels.
  - Also uses "traded" Tariffs measure (to deal with non traded sector issue).

Topalova (2010): Identification Strategy for Tariff Changes

Panel G: Correlation of Industry Tariffs in 1997 and 1987



Panel H: Tariff Decline and Industry Tariffs in 1987



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Topalova and Khandelwal (2010)

Table 2: Declines in Trade Protection and Pre-Reform Industrial Characteristics

Log Real Wage (1)	Share of Non-production Workers (2)	Capital Labor ratio (3)	Log Output (4)	Factory size (5)	Log Employment (6)	Growth in Output 82-87 (7)	Growth in Employment 82-87 (8)	Observations in each regression (9)
Panel A: Output Tariffs								
0.049	0.300	0.000	0.002	0.000	-0.028	0.000	0.001	135
[0.069]	[0.425]	[0.033]	[0.035]	[0.000]	[0.024]	[0.000]	[0.001]	
Panel B: Input Tariffs								
0.096**	0.553	0.011	-0.007	0.000	-0.033	0.000	0.000	129
[0.045]	[0.347]	[0.019]	[0.010]	[0.000]	[0.020]	[0.000]	[0.000]	
Panel C: Effective Rates of Protection								
0.039	0.348	-0.006	0.018	0.000	-0.031	0.000	0.001	129
[0.130]	[0.864]	[0.059]	[0.060]	[0.000]	[0.046]	[0.001]	[0.001]	

Note: The data used in this table are from the 1987 ASI which covers all mining and manufacturing industries. Each cell represents a *separate* regression on either output tariffs (panel A), input tariffs (panel B) or effective rates of protection (panel C) on the variable in the column heading. The number of observations are reported in column 9 (note that the number of observations for regressions in column 6 is one less than that reported column 9). All regressions include indicators for industry use type: Capital Goods, Consumer Durables, Consumer Non-Durables and Intermediate. The regressions are weighted by the square root of the number of factories. Robust standard errors are reported in parantheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

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- Question 3: Why tariffs?
    - Looking under the lamppost? What else might we want to use?

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- Question 3: Why tariffs?
  - Looking under the lamppost? What else might we want to use?
- Question 4: How to measure real income?
  - Appropriate price index? (Topalova proceeds with standard CPI-like price indices, but construction of these requires strong assumptions on how to handle product quality and variety. Atkin et al (2018) develop Engle curve-based approach to correct for these concerns.)

Topalova (2010): 3.9pp increase for avg. 5.5pp tariff drop

Table 4a. Effect of Trade Liberalization on Poverty and Inequality in Indian Districts

	I. RURAL				II. URBAN			
	Tariff	TrTariff	IV-TrTariff	IV-TrTariff, Init TrTariff	Tariff	TrTariff	IV-TrTariff	IV-TrTariff, Init TrTariff
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A. Dependent variable: Poverty Rate							
Tariff Measure	-0.287 **	-0.297 ***	-0.834 ***	-0.687 ***	-0.215	-0.065	-0.156	-0.403
	(0.118)	(0.084)	(0.250)	(0.225)	(0.190)	(0.156)	(0.353)	(0.275)
Obs	725	725	725	725	703	703	703	703
	Panel B. Dependent variable: Poverty Gap							
Tariff Measure	-0.129 ***	-0.114 ***	-0.319 ***	-0.206 ***	-0.084	-0.032	-0.076	-0.131
	(0.038)	(0.021)	(0.073)	(0.075)	(0.052)	(0.046)	(0.101)	(0.087)
Obs	725	725	725	725	703	703	703	703
	Panel C. Dependent variable: StdLog Consumption							
Tariff Measure	-0.086	-0.094	-0.265	-0.161	0.092	0.108	0.257	0.213
	(0.154)	(0.082)	(0.228)	(0.183)	(0.094)	(0.115)	(0.295)	(0.250)
Obs	725	725	725	725	703	703	703	703
	Panel D. Dependent variable: Log Deviation of Consumption							
Tariff Measure	-0.016	-0.020	-0.057	-0.020	0.034	0.090	0.215	0.172
	(0.066)	(0.042)	(0.115)	(0.071)	(0.062)	(0.066)	(0.174)	(0.144)
Obs	725	725	725	725	703	703	703	703
	Panel E. Dependent variable: Log Average Per Capita Expenditures							
Logmean	-0.015	0.132	0.370	0.552	-0.063	-0.126	-0.301	0.048
	(0.314)	(0.183)	(0.522)	(0.433)	(0.150)	(0.212)	(0.521)	(0.468)
Obs	725	725	725	725	703	703	703	703

Note: All regressions include year and district dummies. Standard errors (in parentheses) are corrected for clustering at the state year level. Regressions are weighted by the square root of the number of people in a district. Significance at the 10 percent level of confidence is represented by a *, at the 5 percent level by **, and at the 1 percent level by ***.

Kovak (2013)

- Kovak (2013) performs a similar exercise to Topalova (2010), but with some attractive extensions:
  - The estimating equation emerges directly from a SF model.
  - The estimating equation is similar to Topalova (2010), but with a slight alteration to the way that Tariff_{dt} is calculated (he uses different weights and different treatment of the non-traded sector).
  - Unlike Topalova (2010), Kovak (2013) finds economically and statistically significant migration responses: people appear to move around the country in response to (national) tariff changes, to get closer to favored industry-specific factors like capital/land.
  - Related to "why tariffs?" above: In early draft, tariff cuts from 1987-1995 don't relate to price changes, but from 1990-1995, they do? Not so clear Tariffs are what we really want, other than for exogeneity?

Kovak (2013): Model

- Consider general SF model, but with multiple regions r. For now consider one region.
- Many industries i. Each with specific factor K_i. One factor L that is mobile across sectors (and in principle across regions).
- Factor market clearing then requires (where a_{fi} is amount of factor f required to produce in industry i):

$$a_{Ki} Y_i = K_i \tag{1}$$

$$\sum_i a_{Li} Y_i = L \tag{2}$$

- Differentiating this yields $\sum_i \lambda_i(\hat{a}_{Li} - \hat{a}_{Ki}) = \hat{L}$ where $\lambda_i \equiv \frac{L_i}{L}$
- Perfect competition requires $a_{Li} w + a_{Ki} r_i = p_i$. Differentiating that gives $(1 - \theta_i)\hat{w} + \theta_i \hat{r}_i = \hat{p}_i$ (for all i), where $\theta_i \equiv \frac{r_i K_i}{p_i Y_i}$.

- Letting σ_i be the elasticity of substitution between K_i and L in industry i we have (by definition):

$$\hat{a}_{Ki} - \hat{a}_{Li} = \sigma_i(\hat{w} - \hat{r}_i) \tag{3}$$

- So combining the previous expressions we have

$$\sum_i \lambda_i \sigma_i (\hat{r}_i - \hat{w}) = \hat{L} \tag{4}$$

- This can be re-written as:

$$\hat{w} = \frac{-\hat{L}}{\sum_{i'} \lambda_{i'} \frac{\sigma_{i'}}{\theta_{i'}}} + \sum_i \beta_i \hat{p}_i \tag{5}$$

- With $\beta_i \equiv \frac{\lambda_i \frac{\sigma_i}{\theta_i}}{\sum_{i'} \lambda_{i'} \frac{\sigma_{i'}}{\theta_{i'}}}$

Kovak (2013): Model

- Kovak (2013) then takes this to the data, with the following additions/simplifications:
  - In baseline, no migration, so $\hat{L} = 0$. (But see online appendix for those results, which are interesting.)
  - No information on σ_i, so follows Shoven and Whalley's "Idiot's Law of Elasticities": until proven otherwise, all elasticities are $= 1$, i.e. Cobb-Douglas (not a law to be followed blindly!!)
  - Allows for extension to non-traded goods produced (and differently so) in each region. This doesn't change anything qualitatively but does dampen the formulae quantitatively, as is intuitive.
  - Assuming perfect pass-through of tariffs into prices (NB: the evidence for that is actually quite thin where people have been able to look) Kovak defines a region's tariff change (RTC_r) as:

$$RTC_r \equiv \sum_i \beta_{ir} \Delta \ln(1 + \tau_i) \tag{6}$$

  - With $\beta_{ir} \equiv \frac{\lambda_{ir} \frac{1}{\theta_i}}{\sum_{i'} \lambda_{i'r} \frac{1}{\theta_{i'}}}$

Kovak (2013): Model

- Kovak (2013) then estimates regression:

$$\Delta \ln w_r = \alpha + \rho_i RTC_r + \varepsilon_r. \tag{7}$$

- What sign and magnitude do we expect the coefficient ρ to take?
    - Model here with no labor mobility predicts $\rho = 1$.
    - Polar opposite model with instantaneous and costless labor mobility would predict $\rho = 0$.

Kovak (2013): Tariff variation (a la Topalova)

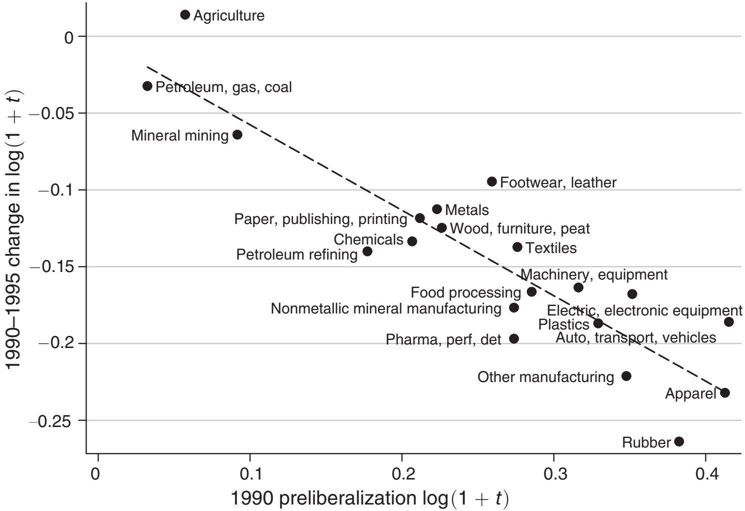


FIGURE 1. RELATIONSHIP BETWEEN TARIFF CHANGES AND PRELIBERALIZATION TARIFF LEVELS

Note: Correlation: −0.899; regression coefficient: −0.556; standard error: 0.064; t: −8.73.

Kovak (2013): RTC_r changes by region r

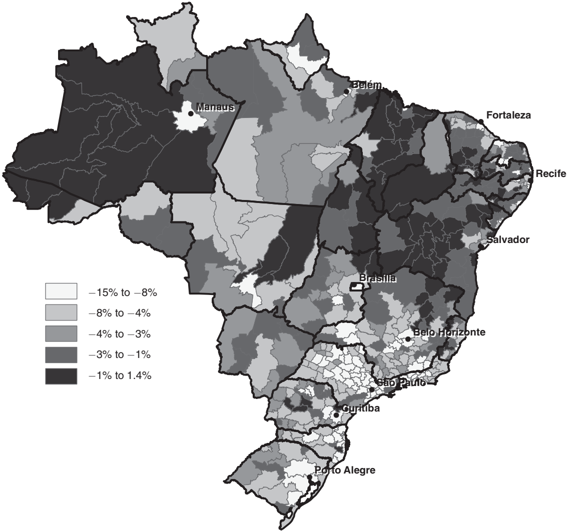


FIGURE 3. REGION-LEVEL TARIFF CHANGES

Notes: Weighted average of tariff changes. See text for details.

Kovak (2013): Main Results

Table 1—The Effect of Liberalization on Local Wages

	Main		No labor share adjustment		Nontraded price change set to zero		Nontraded sector workers' wages	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Regional tariff change	0.404	0.439	0.409	0.439	2.715	1.965	0.417	0.482
Standard error	(0.502)	(0.146)***	(0.475)	(0.136)***	(1.669)	(0.777)**	(0.497)	(0.140)***
State indicators (27)	—	X	—	X	—	X	—	X
Nontraded sector								
Omitted	X	X	X	X	—	—	X	X
Zero price change	—	—	—	—	X	X	—	—
Labor share adjustment	X	X	—	—	X	X	X	X
R^2	0.034	0.707	0.040	0.711	0.112	0.710	0.037	0.763

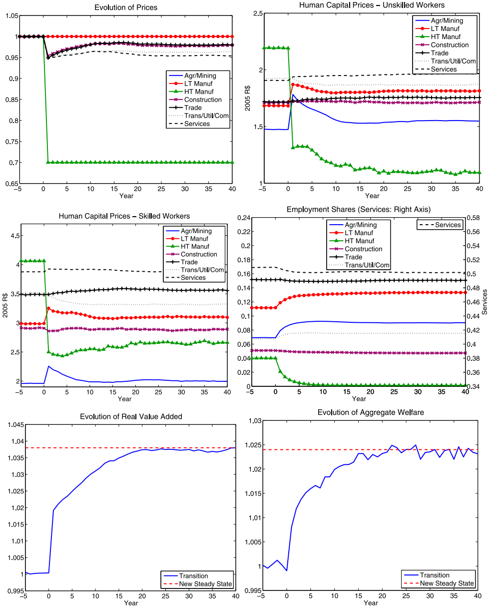
Notes: 493 microregion observations (Manaus omitted). Standard errors adjusted for 27 state clusters (in parentheses). Weighted by the inverse of the squared standard error of the estimated change in log microregion wage, calculated using the procedure in Haisken-DeNew, and Schmidt (1997).

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Dix-Carneiro (Ecta. 2014)

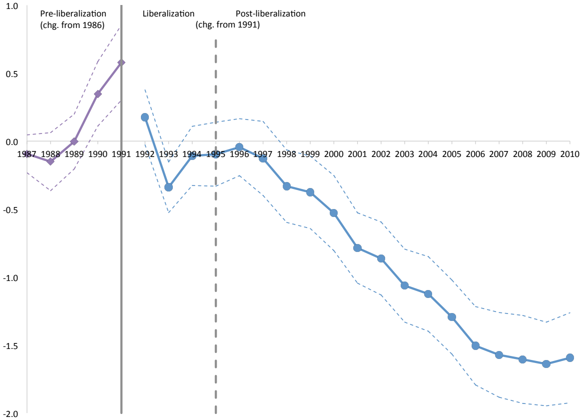
- Kovak (2013) assumed that labor was fully and instantaneously mobile across industries. What about adjustment costs?
- Dix-Carneiro (2014) develops and estimates a rich model of worker-level adjustment costs using remarkable panel data (employee-employer matched data, though the employer dimension is not featured here, apart from the employer's industry) from the universe of formal sector workers in Brazil from 1986-2005.
- Key features:
  - Roy-like model: workers choose which sector to work in
  - But dynamic: workers have rational expectations over the future path of wages in each sector
  - In addition, wage depends on age and sector-specific experience.
  - Workers are heterogeneous in terms of observables (e.g. gender, education)
  - Cost of switching sectors (different for each pair)
- GMM estimation drawing on tools in Lee and Wolpin (Ecta., 2006)

Dix-Carneiro (2014): Counterfactual Results



Dix Caneiro and Kovak (AER, 2017): Timepaths of Effects

Figure 3: Regional log Formal Earnings Premia - 1992-2010



Each point reflects an individual regression coefficient, $\hat{\theta}_t$, following (3), where the dependent variable is the change in regional log formal earnings premium and the independent variable is the regional tariff reduction (RTR), defined in (2). Note that the RTR always reflects tariff reductions from 1990-1995. For blue circles, the changes are from 1991 to the year listed on the x-axis. For purple diamonds, the changes are from 1986 to the year listed. All regressions include state fixed effects, and post-liberalization regressions control for the 1986-1990 outcome pre-trend. Negative estimates imply larger earnings declines in regions facing larger tariff reductions. Vertical bars indicate that liberalization began in 1991 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 112 mesoregion clusters.

Autor, Dorn and Hanson (2013)

- Use the same local labor market methodology to tackle major political issue: what is effect of Chinese competition on US workers?
- Look at Commuting-Zone level unemployment, labor force participation, wages, transfer payments, migration.
- Rather than weighting changes in tariffs by initial industrial composition to get "trade exposure", weight change in imports from China to get "China exposure".
- One worry: Demand shocks for US products. Solution: IV with change in imports into other OECD countries. Does this solve the problem? (Also use a gravity IV to help here).
- Another worry: China shock correlated with rise of developing-world exports of low-skill manufactures. Would we have not seen effects of this type had China not liberalized in 1978?

Autor, Dorn and Hanson (2013):

\$1,000 rise in a CZs import exposure per worker reduces manufacturing employment per working-age population by 0.75%

TABLE 2—IMPORTS FROM CHINA AND CHANGE OF MANUFACTURING EMPLOYMENT IN CZS, 1970–2007: 2SLS ESTIMATES

Dependent variable: 10 × annual change in manufacturing emp/working-age pop (in % pts)

	I. 1990–2007			II. 1970–1990 (pre-exposure)		
	1990–2000 (1)	2000–2007 (2)	1990–2007 (3)	1970–1980 (4)	1980–1990 (5)	1970–1990 (6)
(Δ current period imports from China to US)/worker	−0.89*** (0.18)	−0.72*** (0.06)	−0.75*** (0.07)			
(Δ future period imports from China to US)/worker				0.43*** (0.15)	−0.13 (0.13)	0.15 (0.09)

Notes: $N = 722$, except $N = 1,444$ in stacked first difference models of columns 3 and 6. The variable "future period imports" is defined as the average of the growth of a CZ's import exposure during the periods 1990–2000 and 2000–2007. All regressions include a constant and the models in columns 3 and 6 include a time dummy. Robust standard errors in parentheses are clustered on state. Models are weighted by start of period CZ share of national population.

Autor, Dorn and Hanson (2013)

- Increased exposure to China reduces employment/wages/LFP in highly exposed CZs relative to less exposed CZs.
- Transfer benefits payments for unemployment, disability, retirement, and healthcare also rise sharply.
    - 10 percent of unemployed move onto disability benefits. Why is this happening? Why is it so bad?

Autor, Dorn and Hanson (2013)

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- Transfer benefits payments for unemployment, disability, retirement, and healthcare also rise sharply.
  - 10 percent of unemployed move onto disability benefits. Why is this happening? Why is it so bad?
- So has China made US workers worse off? Has it made the US worse off?

Some other work using regional incidence...

- Autor, Dorn, Hanson and Majlesi (2016): Importing Political Polarization? The Electoral Consequences of Rising Trade Exposure
- Hakobyan and McLaren (2016): Looking For Local Labor Market Effects Of Nafta
- Adao (2016): Worker Heterogeneity, Wage Inequality, and International Trade: Theory and Evidence from Brazil

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- Adao (2016): Worker Heterogeneity, Wage Inequality, and International Trade: Theory and Evidence from Brazil
- Related literature uses "uncertainty shocks" to different industries when US granted Permanent Normal Trade Relations to China in 2000:
  - Across Industry Analysis: Pierce and Schott (AER, 2016): The Surprisingly Swift Decline of U.S. Manufacturing Employment
  - Pierce and Schott (2016): Trade Liberalization and Mortality: Evidence from U.S. Counties
  - Che, Lu, Pierce, Schott and Tao (2016): Does Trade Liberalization with China Influence U.S. Elections?

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  - **Introduction to Trade and Wage Inequality.**
  - Stylized facts about recent changes in wage inequality.
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    - Michaels (2008) within the US.
    - Other approaches.

Trade and Wage Inequality

- So far we have been talking about relative wages across locations, but not to think about wage inequality, rather to try and get a sense of aggregate effects of trade (i.e. treating regions as SOEs to control for time trends).

Recall: The Heckscher-Ohlin Model

- Recall that the HO framework makes a number of strong predictions about factor prices and factor markets:
  1. Stolper-Samuelson derivatives: $\frac{dw_c^k}{dp_{ci}}$ (where c is country, k is factor, and i is industry). We will focus on this today. These derivatives are central to the traditional HO approach to 'trade and wages'.
  2. Rybczinski derivatives: $\frac{dx_{ci}}{dV_c^k}$. This is the focus of a small part of the literature on the effects of immigration on labor markets. (Most of this literature is in the field of Labor Economics, in which these Rybczinski effects are not of primary interest. But see Lewis (2004) on Mariel boatlift and Card (2009, Ely lecture) for discussion of Rybczinski effects).
  3. Equivalence of SS and Rybczinski derivatives: if the number of factors equals the number of goods, $\frac{dw_c^k}{dp_{ci}} = \frac{dx_{ci}}{dV_c^k}$. To my knowledge, this has not been explored empirically.

Recall: The Heckscher-Ohlin Model

- Strong HO predictions about factor prices and factor markets, continued:

    4. The factor price insensitivity theorem: reallocations of factors across countries (eg migration) won't affect factor prices if the pre- and post-allocations are both in the FPE set. This is the focus of the majority of the immigration literature (which is subject to much debate and hasn't been connected that well to the FPI theorem). Similar argument applies to other changes in "endowments", eg "Women, War and Wages" (Acemoglu, Autor, Lyle, JPE 2004).

    5. Factor price equalization. Clearly rejected in international data (but is this just technology differences, as in Trefler (1993)?). Bernard, Redding and Schott (2005) have developed robust tools for testing this within the UK and the US.

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The Facts About Changes in Wage Inequality

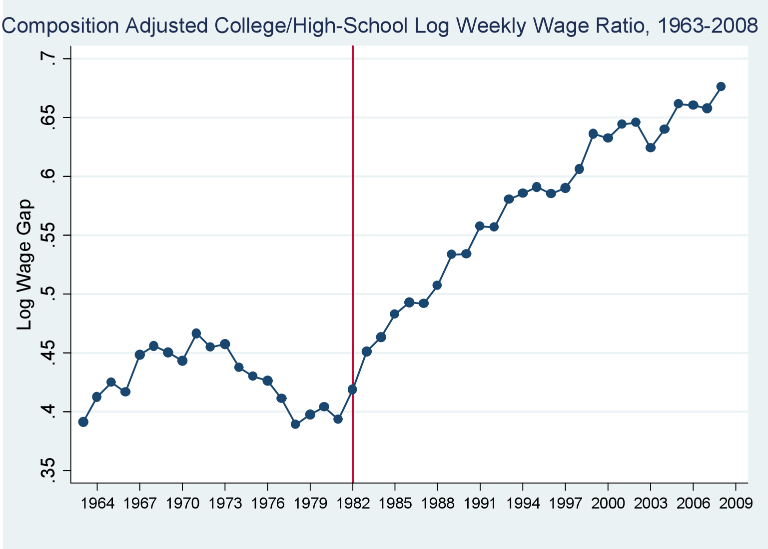
- We start with a brief summary of the key features of the data.
    - Clearly this will only scratch the surface of what has been a dominant theme in Labor Economics for the past 20 years.
    - But David Autor and Daron Acemoglu teach and have taught an outstanding course (14.662) on this topic, for which lecture notes exist on Stellar/OCW.

Wage Inequality Changes in the US

- A central focus has been the rise in wage inequality in the US.
- Of particular interest to trade economists has been the rise in the 'skilled wage premium' (which in the data is usually taken to be just the 'college premium').
  - A similar rise has occurred in the UK, and (according to more recent evidence) Germany.
  - In other OECD countries the changes have been more mixed. (See Autor and Katz (1999 Handbook chapter) and Autor and Acemoglu (2011 Handbook chapter) for details).

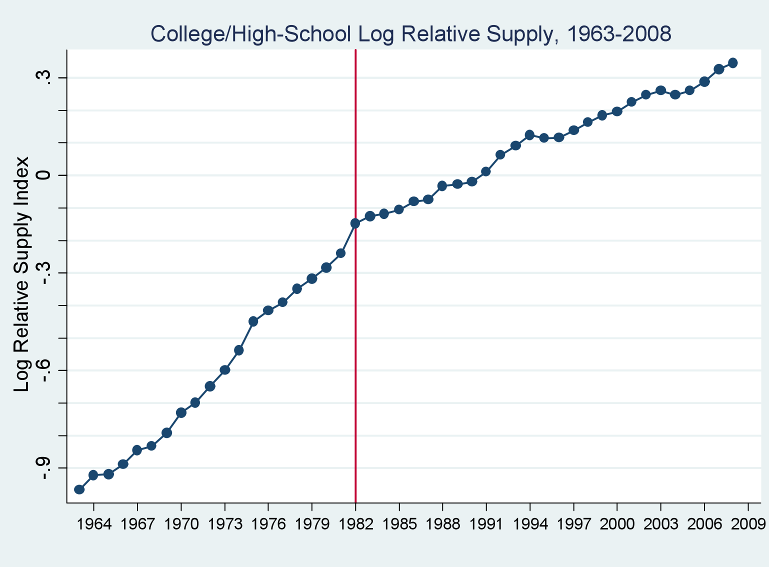
Wage Inequality Changes in the US

Acemoglu and Autor (Hbk Labor Econ, 2011)



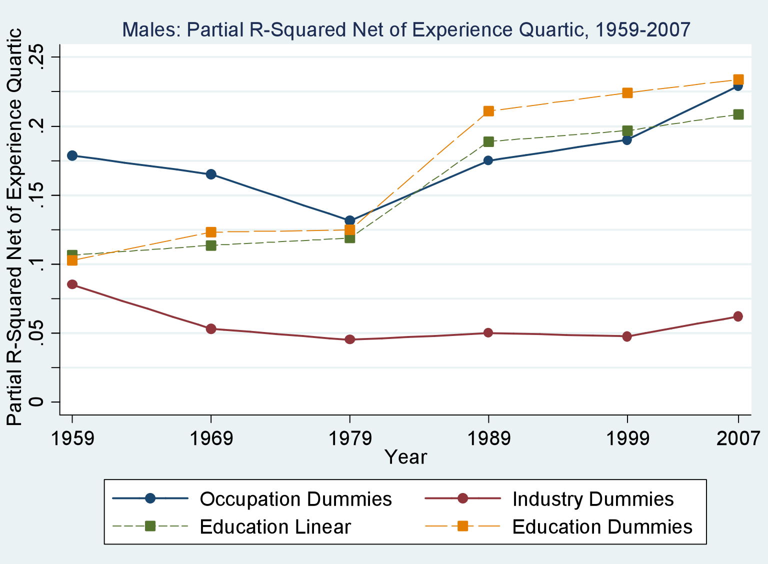
Wage Inequality Changes in the US: Supply or Demand?

Acemoglu and Autor (Hbk Labor Econ, 2011)



Wage Inequality Changes in the US: Decompositions

Acemoglu and Autor (Hbk Labor Econ, 2011)



Plan for Today's Lecture

- "Regional Incidence" approaches to measuring the effects of Trade shocks.
    - Topalova (2010), Kovak (2013), Autor, Dorn and Hanson (2013)

- **Trade and Wage Inequality**
    - Introduction to Trade and Wage Inequality.
    - Stylized facts about recent changes in wage inequality.
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Can Trade (and/or Offshoring) Explain These Facts?

- In principle, yes, since this was a time of rapid expansion of trade.
  - The details of this argument, however, make it harder to sustain.
  - We will discuss this in more detail shortly.
- Other explanations (which 14.662 handles in great detail):
  - Skill-biased technical change.
  - Capital-skill complementarity (along with K accumulation).
  - Skill-biased organizational change.
  - Superstar markets (with a growing 'market size').
  - Institutional changes (declining unionization and minimum wages).

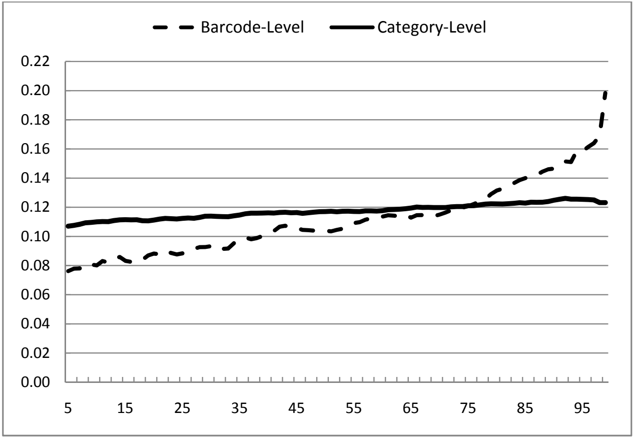
Aside on 'Real' Wage Inequality

- Using a CPI that is the same for all workers, the drop in unskilled relative *nominal* wages is mirrored by a drop in relative *real* wages.
- However, recent work has revisited the assumption that all workers buy all goods in the same shares:
  - Broda and Romalis (2009) use Homescan (AC Nielsen) consumer scanner data to look at what goods different income groups actually buy. This markedly offsets the rise in 'real' wage inequality (for a CPI based on everything you can buy at a store like Walmart). And even if one used the BLS's raw CPI data to build different CPIs for each income quantile, the result would be way off the mark compared to scanner data.
  - Moretti (2009) notes that the rich (and the skilled) tend to choose to live in expensive locations, so they spend a greater share of their income on 'housing services'. Again, this does a lot (22 %) to offset rise in 'real' wage inequality (when 'real' includes house prices).
  - But what if quality/variety changes are disproportionately favoring rich? Some evidence for this in Jaravel (2016).

Broda and Romalis (2009)

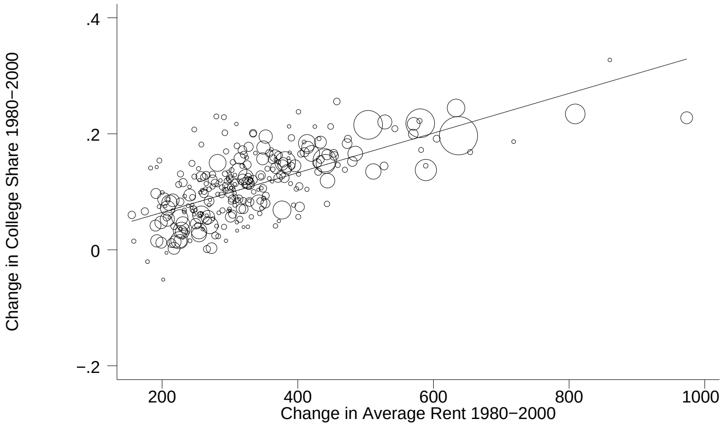
How food inflation differs across the income distribution, and differently when using CPI data and scanner data

Figure 12: Food Price Inflation by Percentile Applying Income-Specific Weights to Price Indexes for 640 Food Categories 1994-2005



Moretti (2009)

Skilled workers appear to reside in increasingly expensive cities



Trade Liberalization and Wage Inequality in LDCs

- Goldberg and Pavcnik (JEL 2007) survey the literature on the distributional consequences of trade liberalization in developing countries.
  - Winters, McCulloch and McKay (JEL 2004) was an earlier survey with a particular emphasis on poverty (ie lower end of income distribution).
- GP (2007)'s Table 1 summarizes the descriptive evidence.
  - This documents a striking set of changes in (the best available measures of) wage inequality around trade liberalization episodes in a wide (and probably representative) array of countries.
  - But this table also highlights how much else changed, apart from trade liberalization, in these episodes.

Goldberg and Pavcnik (2007)

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TABLE 1
GLOBALIZATION AND INEQUALITY IN SELECT DEVELOPING COUNTRIES

	1970s	1980s	1990s
MEXICO			
Globalization Measures		Unilateral trade liberalization 1985–87 (WTO entry) Devaluation Maquiladoras liberalization (1983) FDI liberalization (1989) Immigration	NAFTA (1994) Peso Crisis Maquiladoras expansion FDI Immigration
Inequality			
Skill premium		Increased	Increased until mid-1990s Stable/declined after mid-1990s Increased between 2000–1990
Wage white collar/ Wage blue collar	Declined 1965–80	Increased	Increased until mid-1990s Stable after mid-1990s
90-10 log wage differential	N.A.	Increased	Increased up to 1996 Stable/decline after mid-1990s
Gini of log wages		Increased	Increased up to mid-1990s Stable/decline after mid-1990s
Income Inequality (Gini)	Declined	Increased	Stable/decline
Other Reforms		Privatization Labor Market Reform Deregulation	Banking Crisis

Goldberg and Pavcnik (2007)

Deregulation

COLOMBIA

Globalization Measures	Partial Trade Reform starting 1979	Gradual trade liberalization starting 1985	Trade liberalization 1990–91 Devaluation
Inequality (urban)			
Skill Premium		Slightly Declined	Increased
90–10 log wage differential		Slightly Declined 1986–90	Increased
Gini of log wages		Stable/ Slight Decline	Increased
Income Inequality (Gini)	Declined	Stable/Increased	Stable
Other Reforms			Labor market reform 1990 Banking reform 1993

ARGENTINA

Globalization Measures	Short Trade Reform (1976–82) Appreciation	Unilateral Trade Liberalization (1989–93) Appreciation	Trade liberalization cont. Mercosur 1991
Inequality (urban)			
Skill Premium		Decreased	Increased
Gini of log wages		Increased	Increased
Income Inequality	Increased	Increased	Increased
Other Reforms		Macroeconomic crisis (1988–89) Privatization Deregulation Financial Liberalization in the late 1980s	Deregulation Privatization Financial liberalization in early 1990s Convertibility Plan

Goldberg and Pavcnik (2007)

TABLE 1 *(continued)*

	1970s	1980s	1990s
BRAZIL			
Globalization Measures		Partial unilateral trade liberalization (1988 onwards)	Unilateral trade liberalization (ends 1994) Mercosur 1991 Currency Crisis 1998
Inequality (national)			
Skill Premium	N.A.	Stable/Slight Increase	Increased
Mean log deviation of wage	N.A.	Stable/Increased	Stable
Gini of log wages		Stable	Stable/Small decline
Income Inequality	Stable	Increased	Stable/Small decline
Other Reforms		Labor market reform	
CHILE			
Globalization Measures	Trade Liberalization	Devaluation	
Inequality			
Skill Premium	Increased	Increased	Declined early 1990s Overall increased 1990–2000 (national data)
Wage white collar /Wage blue collar		Increased	
Gini of log wages	Increased	Increased	Decreased relative to late 1980s Stable during the 1990s
Income Inequality (national)	Increased	Increased	Stable/Small increase late 1990s
Other Reforms	Structural Reforms Privatization Deregulation Tax Reform	Devaluation Macroeconomic crisis	

Goldberg and Pavcnik (2007)

INDIA

Globalization Measures		Limited Removal of Import Licenses Unilateral	Trade Liberalization 1991 FDI liberalization
Inequality (urban)			
Skill Premium		Relatively stable	Increased
90-10 log wage differential		Increased	Increased more rapidly
Income Inequality			Increased
Consumption inequality		Stable/Slight Increase	Increased
Other Reforms		Industrial delicensing	Tax Reform Financial Reform

HONG KONG

Globalization Measures		Outsourcing to China	Outsourcing to China
Inequality			
Skill Premium (return to education)	Slight decline	Increased	Increased
Wage non-production/Wage production workers	Declined	Increased	Increased

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"Uncomfortable Facts" for an H-O Interpretation of Wage Inequality Changes

1. Wage inequality has risen in both the 'North' and the 'South'.
2. Do *goods* prices even change in the right direction?
3. The bulk of wage inequality rise has been *within* industries.
4. Traded goods are too small a share of the economy to matter much.

Rise in skill premium in both OECD and LDCs?

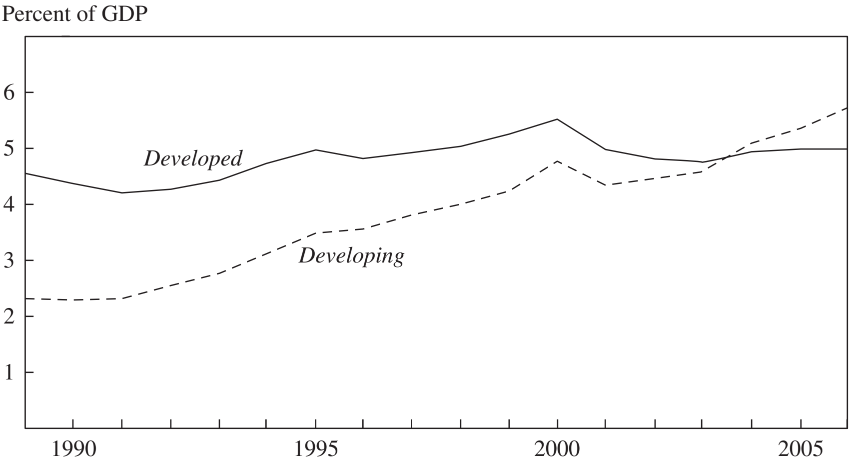
- In the Stolper-Samuelson theorem, relatively skill-endowed countries (eg OECD countries) will see their wage inequality rise when they open with relatively less skill-endowed countries. And the converse should be true for relatively less skill-endowed countries (eg LDCs).
- It is often claimed that is not what has happened in recent decades. That is, that both OECD and LDC countries saw wage inequality rise.
- In reality, the evidence is not entirely clear-cut:
    - Within the OECD: only the US, UK and Germany saw large increases in the skill premium.
    - Within LDCS, Goldberg and Pavcnik (2007) discuss how:
        - It is hard to find an LDC liberalization episode in which other big changes didn't happen at the same time.
        - It is often the case that unskilled-labor-intensive sectors tended to be the most protected pre-liberalization (though that is itself a puzzle for HO), so trade liberalizations themselves have been skill-biased.

Rise in skill premium in both OECD and LDCs?

- In addition, there are aspects of the argument that are incomplete:
  - The "local comparative advantage" argument: A country like India can be both skill-scarce relative to the US and skill-rich relative to Bangladesh. Our simple 2x2x2 HO intuition loses power in the face of such a 3-country world. Davis (1996) develops this argument.
  - Krugman (2008): The timing is way off. The great irony of the great "trade and wages" debate is that it was concerned with data that stopped just before the big rise of "H-O trade" occurred.

Krugman (2008)

Figure 1. Imports of Manufactures from Developed and Developing Countries, 1989–2006



Sources: U.S. International Trade Commission DataWeb and author's calculations.

Changes in Goods Prices

- Goods price changes don't always make sense:
  - A necessary requirement for Stolper-Samuelson effects is that trade policy changes (eg liberalization) affect goods prices, and these then generate S-S effects ($\frac{dw_c^k}{dp_{ci}}$).
  - If the US is integrating with a less-skilled world, the change in goods prices should be greatest in skill-intensive goods.
  - Lawrence and Slaughter (1993) look at the actual change in goods prices in the 1980s and find that the opposite is true!
  - But Leamer (1998) points out that price changes in the 1970s were consistent with HO-style integration.
  - And Robertson (2004) finds price changes in Mexico that are consistent with HO-integration.

- If goods price changes don't line up with what we expect during liberalization episodes, then we must either:
  - Call into question fundamental principles of 'no arbitrage'.
  - Or, Call into question whether current definitions of 'goods' and 'industries' are too aggregated.

Within-Industry Wage Inequality Rise

- The rise of skilled laborers in the US has been largely concentrated *within* industries, rather than between them as H-O would require:
  - Bound, Berman and Griliches (1994) documented this first.
- These industry-level findings are damning. But given how crude an 'industry' is (in the above data), it wouldn't be surprising to expect HO forces to work within industries too.

Trade Is Too Small to Matter (?)

- It's true that most US industries aren't that engaged with trade.
- But if you believe that prices are set on the margin, overall quantities (away from corner solutions— that is, conditional on there being *some* trade) don't matter.
- Leamer (JEL 2007) calls for a distinction between "movement and mobility" of goods, and for a deeper study of "contestability" in international labor markets.
    - Magnac (Ecta, 1991) for a framework for identifying "contestability" of (labor) markets.
    - Manning and Petrongolo (AER, 2017) for a framework for thinking about how large is the local labor market
    - Salvo (RAND, 2010) has a nice paper showing *threat* of foreign entry kept Brazilian Cement prices at world level despite no trade.

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Michaels (ReStat, 2008)

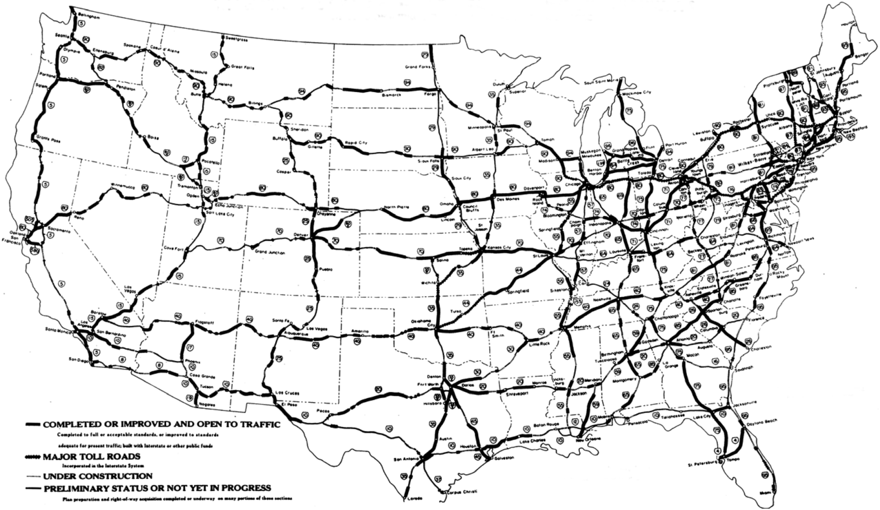
- Michaels (2008) argues that the existing literature on S-S effects lacks a setting in which the causal effect of trade integration on (prices and hence on) relative wages is truly identified.
- In an innovative twist, he uses the roll-out of the US Interstate Highway System (in the 1960s) as a trade integration 'shock' to rural counties that were previously connected to big US cities by only (relatively) low-quality highways.
  - Of course, highway placement is probably not exogenous here.
  - So Michaels (2008) develops a pair of IVs for the placement of the Interstate system.
  - Both IVs work on the principle that that the primary goals of Interstate system planning were (a) to connect big cities (this is why Michaels (2008) focuses on rural counties only) and (b) to achieve military objectives of spanning the country East-West and North-South.
- Another nice feature here is the within-country approach, which means he goes from one data point (per year) to many.

Figure 2.—Routes of the Recommended Interregional Highway System, 1944 plan

Michaels (2008): IV 1 is based on the farsighted 'plan'

Building of the actual network—similar to the plan (so IV is strong)

FIGURE 3.—THE INTERSTATE HIGHWAY SYSTEM IN SEPTEMBER 1966

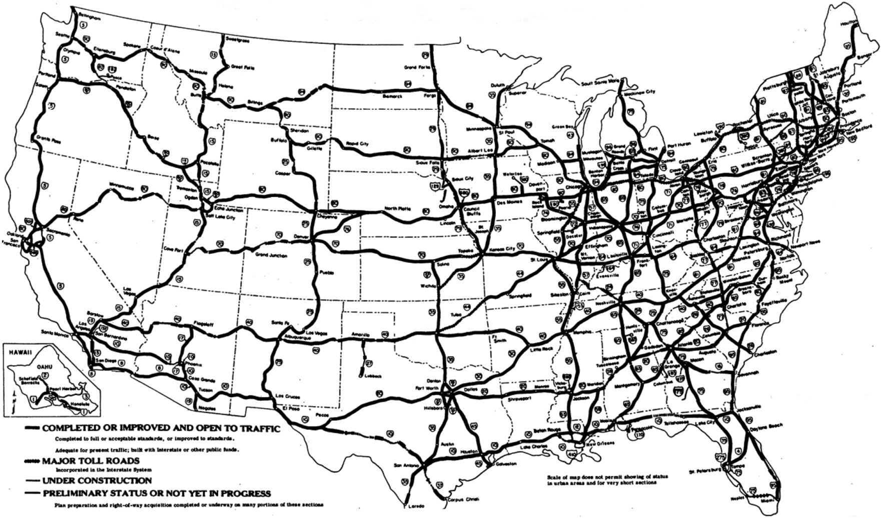


Source: Bureau of Public Roads.

Michaels (2008): IV 1 is based on the farsighted 'plan'

Building of the actual network—similar to the plan (so IV is strong)

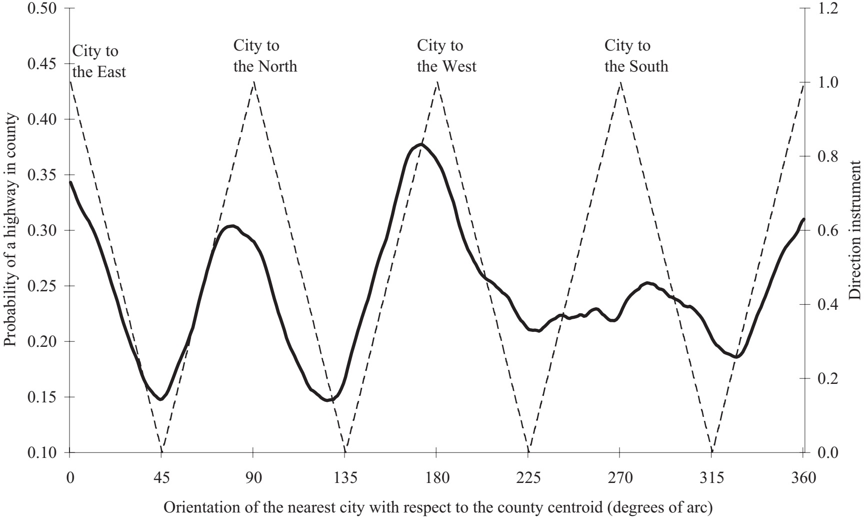
FIGURE 4.—THE INTERSTATE HIGHWAY SYSTEM IN DECEMBER 1975



Source: Federal Highway Administration.

Michaels (2008): IV 2 is based on fact that highways were built north/south and east/west connecting cities

Figure 6.—The Direction to the Nearest City and the Probability an Interstate Highway Crosses a Rural County



Michaels (2008): Empirical Specification

- Michaels (2008) uses decadal census data to estimate regressions of the following form (by OLS and IV):

$$\ln S_{ct} = \alpha_c + \beta_t + \gamma_1 D_{1975} \times H_c + \gamma_2 D_{1975} \times H_c \times s_{c,1950} + \varepsilon_{ct} \quad (8)$$

- Where:
  - S_{ct} is the relative wage bill of non-production workers over production workers (in county c and year t).
  - D_{1975} is a dummy that turns on in 1975 (when the Highway system was complete).
  - H_c is a dummy for whether county c got the Highway or not.
  - $s_{c,1950}$ is the share of residents in county c in 1950 who had a high school diploma (meant to proxy for 'relative skill abundance').

Michaels (2008): Results

TABLE 7.—THE EFFECT OF HIGHWAYS ON THE DEMAND FOR SKILL IN MANUFACTURING

	OLS					IV: Instrument 1944 Plan	IV: Instrument Direction to City
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. Dependent Variable: ln (Relative Wage-Bill of Nonproduction Workers)							
(Post-1975) × highway	0.006	−0.149	−0.168	−0.151	−0.101	−0.223	−1.370
	(0.024)	(0.069)	(0.068)	(0.077)	(0.069)	(0.094)	(2.049)
(Post-1975) × highway × (1950 hs)		0.623	0.609	0.564	0.456	0.802	4.177
		(0.249)	(0.241)	(0.262)	(0.247)	(0.312)	(5.960)
(Post-1975) × (1950 high school)		−0.443	−0.323	−0.208	−0.077	−0.278	−1.200
		(0.148)	(0.213)	(0.255)	(0.093)	(0.271)	(1.683)
Observations	5,795	5,795	5,793	4,455	4,455	4,455	4,455
B. Dependent Variable: ln (Relative Wage of Nonproduction Workers)							
(Post-1975) × highway	−0.051	−0.129	−0.113	−0.113	−0.069	−0.136	−1.259
	(0.020)	(0.059)	(0.059)	(0.059)	(0.058)	(0.077)	(1.573)
(Post-1975) × highway × (1950 hs)		0.313	0.274	0.274	0.130	0.312	3.098
		(0.202)	(0.206)	(0.206)	(0.207)	(0.262)	(4.563)
(Post-1975) × (1950 high school)		−0.251	−0.479	−0.479	0.022	−0.484	−1.145
		(0.134)	(0.220)	(0.220)	(0.085)	(0.230)	(1.285)
Observations	4,456	4,456	4,455	4,455	4,455	4,455	4,455
C. Dependent Variable: ln (Relative Employment of Nonproduction Workers)							
(Post-1975) × highway	0.063	−0.004	−0.037	−0.038	−0.032	−0.087	−0.111
	(0.027)	(0.081)	(0.079)	(0.079)	(0.075)	(0.096)	(1.646)
(Post-1975) × highway × (1950 hs)		0.264	0.289	0.290	0.326	0.490	1.079
		(0.278)	(0.267)	(0.267)	(0.268)	(0.320)	(4.808)
(Post-1975) × (1950 high school)		−0.134	0.276	0.272	−0.099	0.206	−0.055
		(0.179)	(0.257)	(0.258)	(0.103)	(0.276)	(1.373)
Observation	4,461	4,461	4,460	4,455	4,455	4,455	4,455

Notes: All estimates are from a panel of the sample counties that includes county and year dummies. All estimates use data for 1967–1982, and include 1950 population weights. Robust standard errors in parentheses are clustered by county. Columns 1–3 use the full sample, and columns 4–7 use a fixed sample size across panels. Columns 3–7 control for region × year, (distance to nearest city) × year, and (1950 population density) × year interactions, and the fraction of high school graduates among 25+ year-olds. Column 5 uses a state-level index of the fraction of highways completed.

Michaels (2008): Results

- This is strong evidence for S-S style effects at work within the US.
  - This is all the more surprising as the Interstate highway system probably didn't change transportation costs that much.
  - Trucks averaged almost 50 mph before the Interstate system.
- However, Michaels (2008) also looks for evidence of a change in industrial composition and doesn't see any.
  - So perhaps S-S effects are working beneath the level of the (admittedly crude) industry definitions that are in the Census data.
  - Or perhaps something else is at work. *Trade-induced* skill-biased technical change? Bustos (2011 AER) and Bloom, Draca and van Reenen (REStud, 2016) look for this more directly and find some evidence for it.

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Alternative SS approaches:

Which we don't have time to discuss in any detail, but do see the papers.

- The 'factor contents approach':
  - Borjas, Freeman and Katz (1997).
  - Krugman vs Leamer (2000 JIE special issue) debate on this.
  - Burstein and Vogel (2011) show how modern trade models (of the 'gravity' sort) can be brought into this method.
- Burstein and Vogel (JPE, 2016): calibration of a HO-Eaton Kortum model where firms differ in the extent of the skill-bias of the technology they use.
- Single industry studies: Leamer (1998) on the Multi-Fibre Agreement and US textiles.
- Full-blown GE approaches:
  - Porto (JIE, 2006): GE analysis of prices, wages and consumption (and hence welfare) in Brazil.

Alternative Approaches

- A unified treatment of trade and SBTC:
  - What if trade openness is the cause of SBTC?
  - Bloom, Draca and van Reenen (2011) on effect of Chinese competition on European firm technology-upgrading (and comensurate wage effects).
  - Bustos (AER 2011) on trade-induced skill-upgrading in Argentina.
- Trade and labor market frictions:
  - eg Tybout et al (AER, 2016), Helpman et al (Ecta 2010)

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Future Work

- Some rough ideas:
    - Exploit insights from sorting (eg assignment) models (including "optimal transport" literature: Galichon, 2017 book).
    - Serious treatment of multi-country models (e.g. to assess issues like the "local CA" point)
    - Exploit new results in Labor: adding quality differences across workers (Carneiro-Lee, 2009), changes in distributions (Dinardo, Fortin and Lemieux, 1997)
    - Comparing S-S to Rybczinski effects (e.g. a joint treatment of trade integration and immigration).