Real Wage Inequality

Enrico Moretti

University of California, Berkeley and NBER

Introduction

- Wage inequality has increased since 1980

  College premium increased from 40% to 60%

- The existing literature has identified 3 explanations:

  1. Increase in the demand for skills

  2. Decline in the supply of skills

  3. Erosion of labor market institutions that protect low-wage workers

Geographical Differences and Cost of Living Differences

- There are large and increasing differences in the geographical distribution of skilled and unskilled workers

- Skilled workers are increasingly concentrated in cities with high cost of housing.

- Cost of housing is the most important component of CPI.

- Skilled and unskilled workers have experienced different changes in cost of living

Two Questions

1. How does inequality change when differences in the cost of living across skill groups are taken into account?

    - I create a cost of living index that varies across cities
    - I find that the college premium measured in real terms has grown significantly less than the premium measured in nominal terms

2. What are the implications for inequality in well-being?

   - Implications depend on reasons for geographical sorting
   - General equilibrium model of labor and housing markets
   - Relative Demand Shifts (Jobs)

     → Increase in well-being inequality is smaller than the increase in nominal wage inequality
   - Relative Supply Shifts (Amenities)

     → A significant increase in well-being inequality is possible even with limited increase in real wage inequality

Are most of the changes in the geographical location of skilled and unskilled workers driven by relative demand or relative supply shifts?

- I look at the equilibrium relationship between changes in college premium and changes in college share across cities
  - If demand $\rightarrow$ positive relationship
  - If supply $\rightarrow$ negative or no relationship

- OLS and IV evidence is consistent with relative demand shifts

- Most of the changes over time in the geographical location of skilled workers relative to unskilled workers are driven by changes in the relative demand shifts (availability of jobs)

- I conclude that inequality in well-being has increased less than nominal wage inequality

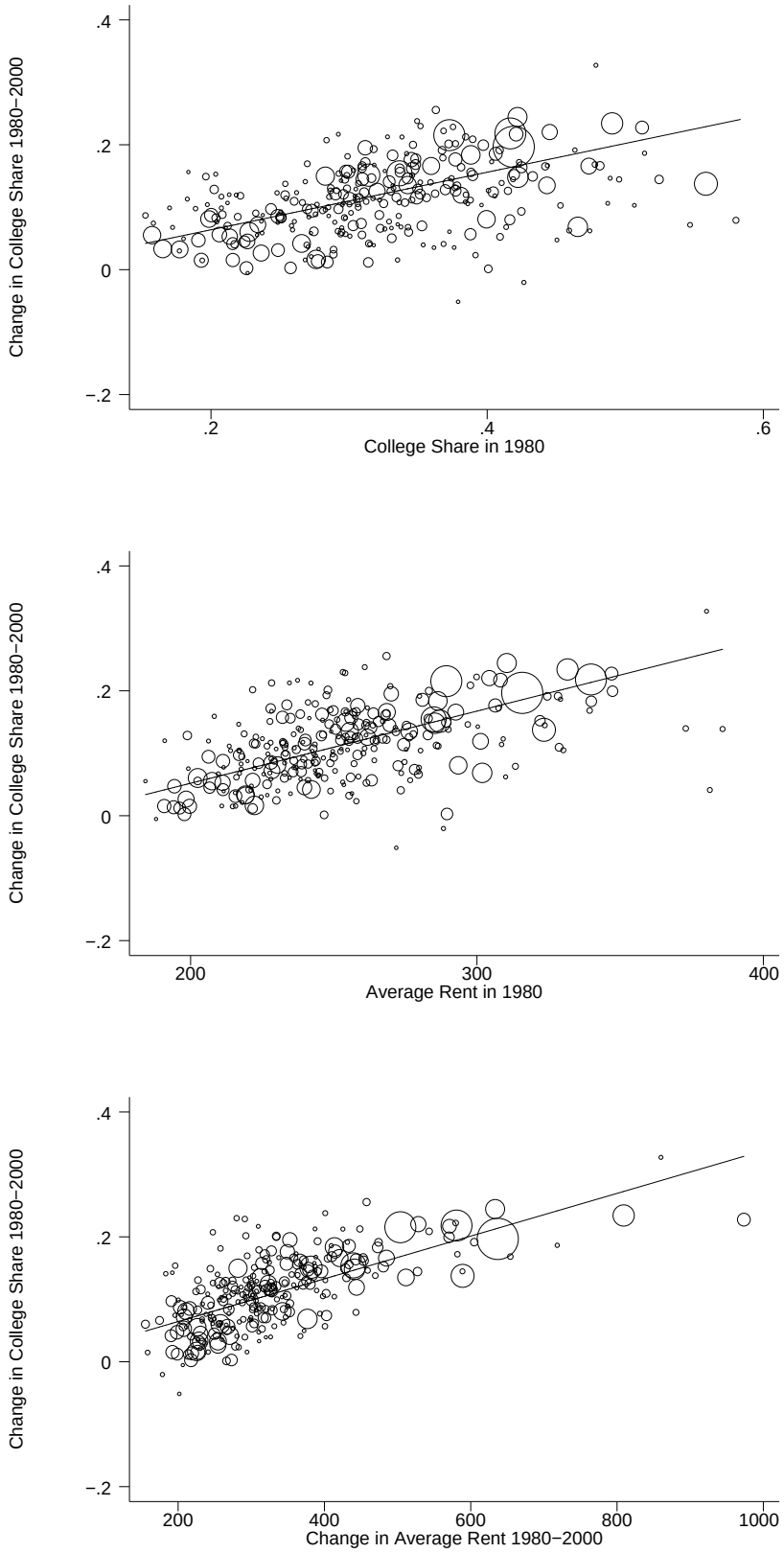
- Findings are consistent with previous studies that identify shifts in labor demand as an important determinant of the increase in inequality
  - Skill-biased technical change
  - Product demand shifts across industries with different skill intensities
- My findings point to an important role for the local component of demand shifts

Table 1: Metropolitan Areas with the Largest and Smallest Share of College Graduates in the Workforce

	College Share in 2000	Change in College Share 1980-2000	Monthly Rent in 2000	Change in Monthly Rent 1980-2000
Metropolitan Areas with the Largest College Share in 2000				
Stamford, CT	.58	.26	1109	759
San Jose, CA	.48	.15	1231	892
Washington, DC/MD/VA	.48	.08	834	532
Boston, MA-NH	.45	.17	854	556
San Francisco-Oakland-Vallejo, CA	.44	.12	1045	724
Ann Arbor, MI	.43	.02	724	417
Columbia, MO	.43	.06	485	239
Raleigh-Durham, NC	.42	.12	669	427
Fort Collins-Loveland, CO	.42	.10	693	419
Trenton, NJ	.41	.14	776	494
Metropolitan Areas with the Smallest College Share in 2000				
Ocala, FL	.15	.02	514	285
Williamsport, PA	.15	.04	434	229
Lima, OH	.15	.05	444	226
Hickory-Morgantown, NC	.15	.02	486	286
Johnstown, PA	.14	.01	370	165
Flint, MI	.14	.01	481	217
Vineland-Milville-Bridgetown, NJ	.13	.01	617	368
Mansfield, OH	.13	.01	460	242
Visalia-Tulare-Porterville, CA	.13	.00	495	270
Danville, VA	.12	.02	401	231

Notes: Share of college graduates is the share of full-time workers between 25 and 60 years old with a college degree or more who live in the relevant city. Monthly rent refers to the average rent paid for a 2 or 3 bedroom apartment.

Figure 1: How Changes in the Share of College Graduates Relate to the Initial Share of College Graduates, the Initial Cost of Housing and Changes in Cost of Housing



Notes: Average rent is the average monthly rental price of a two or three bedroom apartment.

The official consumer price index

- Changes in the CPI are a weighted average of changes in the price of the goods in a representative consumption basket

- The weights reflect the share of income that the average consumer spend on each good.

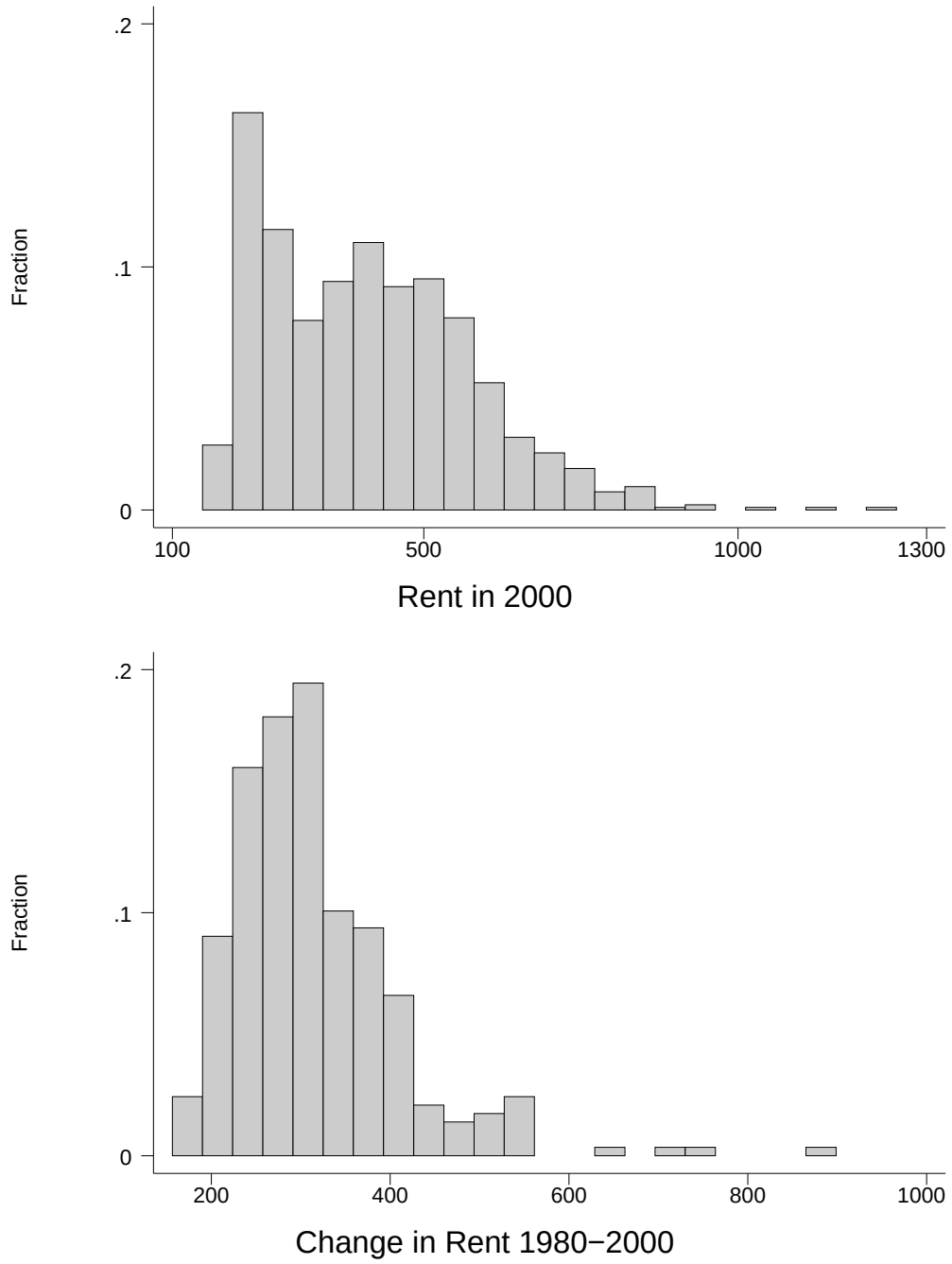
- To measure cost of housing, BLS uses monthly rent.

Table 2: Relative Importance of the Main Aggregate Components in the BLS Consumer Price Index (CPI-U)

Housing	42.7%	
Shelter		32.8%
Fuels and Utilities		5.3%
Other Housing		4.6%
Transportation	17.2%	
Food and Beverages	14.9%	
Medical Care	6.2%	
Education and Communication	6.0%	
Recreation	5.5%	
Apparel	3.7%	
Other Goods and Services	3.5%	

Notes: Entries are the share of the main aggregate components of the CPI-U. For more disaggregated categories see Appendix 4 in Chapter 17 of the Bureau of Labor Statistics's "Handbook of Methods" (2007).

Figure 2: The Distribution of Average Rental Costs Across Metropolitan Areas: 2000 Cross-Section and 1980-2000 Change



Notes: The top panel shows the distribution of the average cost of renting a 2 or a 3 bedroom apartment in year 2000. The bottom panel shows the distribution of the changes between 1980 and 2000 in the average cost of renting a 2 or a 3 bedroom apartment.

A new consumer price index: Local CPI 1

- I closely follow the methodology that BLS uses, while allowing for increases in the cost of housing to vary across cities and skill groups.

- I use the price of the average two or three-bedroom apartment for a given city and skill group

- I use the BLS weights in the relevant year

Local CPI 2

- While the cost of housing is the most important component of the CPI, the price of other goods may also vary across cities

- Local CPI 2 allows for variation both in the cost of housing and in the cost of non-housing consumption to vary across metropolitan areas

- Important data limitation: I impute the part of local non-housing prices that varies systematically with housing costs

Imputation

- BLS provides local CPI for 22 MSA's:

$$\text{BLS}_{ct} = w\text{HP}_{ct} + (1 - w)\text{NHP}_{ct} \qquad (1)$$

- Non-housing costs can be divided in two parts

$$\text{NHP}_{ct} = \pi\text{HP}_{ct} + v_{ct} \qquad (2)$$

πHP_{ct} is the component of non-housing costs that varies systematically with housing costs

- I use the 22 MSA's for which a local BLS CPI is available to estimate π

- I then impute non-housing costs to all MSA's

  $E(\text{NHP}_{ct}|\text{HP}_{ct}) = \widehat{\pi}\text{HP}_{ct}$.

Table 3: Changes in the Cost of Living, by Education Group

	1980	1990	2000	Percent Increase 1980-2000
	(1)	(2)	(3)	(4)
Official CPI				
High-School	1	1.53	2.02	102%
College	1	1.53	2.02	102%
Percent Difference	0	0	0	
Monthly Rent				
High-School	247	432	563	127%
College	259	491	642	147%
Percent Difference	4%	11%	14%	
Local CPI 1				
High-School	0.99	1.49	1.95	96%
College	1.01	1.58	2.07	105%
Percent Difference	2%	4%	6%	
Local CPI 2				
High-School	0.98	1.57	2.04	108%
College	1.01	1.71	2.22	119%
Percent Difference	3%	7%	9%	

Notes: Monthly rent refers to the rent paid for a two or three bedroom apartment. Local CPI 1 allows for local variation only in the cost of housing. Local CPI 2 allows for local variation both in the cost of housing and the cost of non-housing goods and services.

Estimates of real return to college

- Standard wage equation. The dependent variable is

  1) nominal wage

  2) real wage (deflated by Local CPI)

- The deflator is not individual specific

Table 4: Nominal and Real Conditional Wage Difference Between Workers with a High School Degree and Workers With College or More, by Year - Baseline Estimates

	1980	1990	2000	1980-2000 Increase	1980	1990	2000	1980-2000 Increase
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Model 1								
Nominal Wage Difference	.40	.53	.60	.20	.35	.47	.53	.18
	(.011)	(.012)	(.013)		(.007)	(.006)	(.007)	
Model 2								
Real Wage Difference - Local CPI 1	.38	.48	.53	.15	.37	.46	.52	.15
	(.010)	(.008)	(.008)		(.008)	(.006)	(.007)	
Percent of Nominal Increase Accounted for by Cost of Living				25%				17%
Model 3								
Real Wage Difference - Local CPI 2	.37	.45	.51	.14	.37	.46	.51	.14
	(.009)	(.008)	(.008)		(.008)	(.006)	(.007)	
Percent of Nominal Increase Accounted for by Cost of Living				30%				22%
MSA Fixed Effects	No	No	No		Yes	Yes	Yes	

Notes: Standard errors clustered by metropolitan area in parentheses. The dependent variable in Model 1 is the log of nominal hourly wage. The dependent variable in Model 2 is the log of real hourly wage, where real hourly wage is the ratio of nominal wage and Local CPI 1. The dependent variable in Model 3 is the log of real hourly wage, where real hourly wage is the ratio of nominal wage and Local CPI 2. All models include dummies for gender and race, a cubic in potential experience, and year effects. Models in columns 5 to 8 also include MSA fixed effects. Sample size is 5,024,221.

Appendix Table 1. Estimates Based on an Alternative Definition of Rental Cost

	1980	1990	2000	1980-2000 Increase	Percent of Nominal Increase Accounted for by Cost of Living
	(1)	(2)	(3)	(4)	(5)
Nominal Wage Difference	.39	.53	.59	.20	
	(.008)	(.012)	(.013)		
Real Wage - Local CPI 3	.32	.41	.44	.12	40%
	(.006)	(.005)	(.004)		
Real Wage - Local CPI 4	.28	.34	.38	.10	50%
	(.006)	(.006)	(.005)		

Notes: Standard errors clustered by metropolitan area in parentheses. The dependent variable in the first row is the log of nominal hourly wage. The dependent variable in the second and third row is the log of real hourly wage, where real hourly wage is the ratio of nominal wage and Local CPI 3 or Local CPI 4. In Local CPI 3 and 4, housing costs are allowed to vary by metropolitan area, skill group, race and number of children in the household. Local CPI 3 only uses local variation in cost of living that arises from variation in cost of housing. (The difference with Local CPI 1 is that in Local CPI 1 cost of housing varies only by MSA, while in Local CPI 3 cost of housing varies by MSA, education group, race and number of children.) Local CPI 4 uses local variation both in cost of housing and cost of non housing good and services. (The difference with Local CPI 2 is that in Local CPI 2 cost of housing varies only by MSA, while in Local CPI 4 cost of housing varies by MSA, education group race and number of children.) All models include dummies for gender and race, a cubic in potential experience, and year effects. Sample size is 4,920,703.

Table 5: Additional Specifications

	1980	1990	2000	1980-2000 Increase	Percent of Nominal Increase Accounted for by Cost of Living
	(1)	(2)	(3)	(4)	(5)
Model 1: ACCRA Non-Housing Prices					
Nominal Wage Difference	.40	.53	.60	.20	
	(.015)	(.009)	(.010)		
Real Wage - ACCRA price Index	.39	.48	.54	.15	25%
	(.012)	(.006)	(.006)		
Model 2: Include Commuting Time					
Nominal Wage Difference	.40	.54	.60	.20	
	(.010)	(.009)	(.011)		
Real Wage - Local CPI 1	.38	.48	.53	.15	25%
	(.008)	(.006)	(.007)		
Real Wage - Local CPI 2	.37	.45	.51	.14	30%
	(.008)	(.007)	(.007)		
Model 3: Include Workers with Less Than 48 Weeks					
Nominal Wage Difference	.43	.57	.62	.19	
	(.009)	(.010)	(.012)		
Real Wage - Local CPI 1	.42	.52	.56	.14	26%
	(.008)	(.007)	(.008)		
Real Wage - Local CPI 2	.41	.49	.53	.12	37%
	(.007)	(.007)	(.007)		
Model 4: Include Immigrants					
Nominal Wage Difference	.40	.54	.61	.21	
	(.011)	(.012)	(.013)		
Real Wage - Local CPI 1	.39	.49	.55	.16	24%
	(.010)	(.009)	(.010)		
Real Wage - Local CPI 2	.38	.46	.52	.14	33%
	(.010)	(.010)	(.010)		
Model 5: Only Urban Workers					
Nominal Wage Difference	.40	.52	.60	.20	
	(.011)	(.008)	(.010)		
Real Wage - Local CPI 1	.39	.49	.55	.16	20%
	(.010)	(.007)	(.007)		
Real Wage - Local CPI 2	.38	.47	.53	.15	25%
	(.010)	(.007)	(.007)		

Notes: Standard errors clustered by metropolitan area in parentheses.

Threat to Validity: Unobserved Housing Quality Changes

- If housing quality is a normal good, increases in the relative earnings for college graduates may result in increases in relative housing quality

- I re-estimate my models holding constant measures of quality from American Housing Survey
  - I first regress housing costs on the vector of available quality measures
  - The residual is the component of the cost of housing that is orthogonal to quality

Table 6: Nominal and Real Conditional Wage Difference Controlling for Quality of Housing, by Year - American Housing Survey

	1980	1990	2000	1980-2000 Increase	Percent of Nominal Increase Accounted for by Cost of Living
	(1)	(2)	(3)	(4)	(5)
Nominal Wage Difference	.37	.47	.56	.19	
	(.019)	(.008)	(.010)		
Real Wage Difference - Not Controlling for Quality					
Real Wage - Local CPI 1	.36	.45	.52	.16	15%
	(.010)	(.006)	(.010)		
Real Wage - Local CPI 2	.35	.44	.51	.16	15%
	(.013)	(.006)	(.010)		
Real Wage Difference - Controlling For Quality					
Real Wage - Local CPI 1	.35	.43	.50	.15	21%
	(.012)	(.007)	(.012)		
Real Wage - Local CPI 2	.34	.42	.49	.15	21%
	(.014)	(.009)	(.014)		

Notes: Standard errors clustered by metropolitan area in parentheses. Data are from the American Housing Survey. Available housing quality variables include square footage, number of rooms, number of bathrooms, indicators for the presence of a garage, a usable fireplace, a porch, a washer, a dryer, a dishwasher, outside water leaks, inside water leaks, open cracks in walls, open cracks in ceilings, broken windows, rodents, and a broken toilet in the last 3 months. The dependent variable is log of yearly earnings.

Interpretation

- Real inequality is lower than nominal inequality and has grown less

- Does this mean that the large increases in wage disparities did not translate into increases in disparities in well-being?

- Not necessarily. Changes in real wages do not necessarily equal changes in well-being.

- Implications for well-being inequality depend on the reasons why college graduates sort into expensive cities

Two alternative hypotheses

- Demand pull

  Relative demand of skilled workers is high in expensive cities because skilled jobs are concentrated there

- Supply push

  Relative supply of skilled workers is high in expensive cities because they have amenities that attract skilled workers

A Simple Model

- Two cities: Detroit (city a) and San Francisco (city b)

- Each city as a competitive economy that produces a single output good y traded on the international market, with price 1

- Two type of workers: skilled workers and unskilled workers

Assumptions

- Workers and firms are perfectly mobile

  $\rightarrow$ In equilibrium workers need to be indifferent between living in Detroit and San Francisco.

  Firms profits need to be equalized across locations.

- Capital is infinitely supplied

- Each worker provides 1 unit of labor

- Labor and housing markets for skilled and unskilled workers within a city are separated

Skilled Workers

- Utility for skilled workers who live in city c is

$$U_c = w_c - r_c + A_c \tag{3}$$

w_c is wage; r_c is cost of housing ; A_c is a local amenity

- In equilibrium

$$U_a = U_b \tag{4}$$

$\rightarrow$ Labor supply in San Francisco is infinitely elastic

$$w_b = w_a + (r_b - r_a) + (A_a - A_b) \tag{5}$$

- I assume that each worker consumes one unit of housing

  $\rightarrow$ The demand of housing in San Francisco is

$$r_b = (w_b - w_a) + r_a + (A_b - A_a) \tag{6}$$

- The supply of housing is

$$r_c = z + k_c N_c \tag{7}$$

- k_c is elasticity of supply of housing, and is determined by geography and local land regulations.

- Cobb-Douglas technology with CRTS

$$\ln y_c = X_c + hN_c + (1-h)K_c \tag{8}$$

- Labor and capital are paid their marginal product.

- Capital is infinitely supplied at given price

Unskilled Workers

Utility and technology for unskilled workers are similar

SCENARIO 1: Demand Pull

- The marginal product of skilled workers increases in San Francisco by Δ

  Productivity of unskilled workers is unchanged.

  $\rightarrow$ relative demand of skilled workers increases

- For example: The dot com boom experienced by the San Francisco in 1990's

What happens to wages and rents?

- $\frac{\Delta}{k_a+k_b}$ skilled workers move from Detroit to San Francisco

- The nominal wage in San Francisco increases by

$$w_{b2} - w_{b1} = \Delta \tag{9}$$

- The cost of housing in San Francisco increases by

$$r_{b2} - r_{b1} = \frac{k_b}{k_a + k_b}\Delta \tag{10}$$

Increase depends on housing elasticities

- In Detroit, nominal wages do not change.

  (Capital flows exactly off-set the decline in labor supply)

- But the cost of housing declines by

$$r_{a2} - r_{a1} = -\frac{k_a}{k_a + k_b}\Delta \tag{11}$$

Who benefits From the Increased Productivity?

- Workers both in San Francisco and Detroit experience an increase in real wages (and utility) by

$$\frac{k_a}{k_a + k_b}\Delta \tag{12}$$

- Landowners in San Francisco are better off by

$$\frac{k_b}{k_a + k_b}\Delta \tag{13}$$

- The split between workers and landowners depend on housing supply elasticities

Two Special cases

1. The supply of housing in San Francisco is fixed ($k_b = \infty$). This is Roback (1982).

   - All the benefit of the productivity increase goes to landowners in San Francisco.
   - Workers are indifferent.

2. The supply of housing in San Francisco is infinitely elastic ($k_b = 0$)

   - All the benefit of the productivity increase goes to workers
   - Landowners in San Francisco are indifferent; landowners in Detroit experience a loss

Distribution of the Shocks

- For relative demand shocks to be consistent with empirical evidence, these shocks can not be concentrated in cities with a small initial share of college graduates

- There need to be some type of agglomeration spillovers

- Beaudry, Doms and Lewis (2008); Berry and Glaeser (2005)

SCENARIO 2: Supply Push

- Productivity is fixed
- But San Francisco becomes more desirable relative to Detroit for skilled workers
- The amenity in San Francisco increases by Δ'

What happens to wages and rents?

- As before, $\frac{\Delta'}{k_a+k_b}$ skilled workers move to San Francisco

- Unlike before, the nominal wage of skilled workers in San Francisco remains constant (because of capital flows. Without capital, wage would decline as in Roback, 1982)

- Workers in both cities experience an increase in utility by

$$\frac{k_a}{k_a + k_b}\Delta' \tag{14}$$

What is the difference between demand pull and supply push?

- For a given increase in nominal wage gap

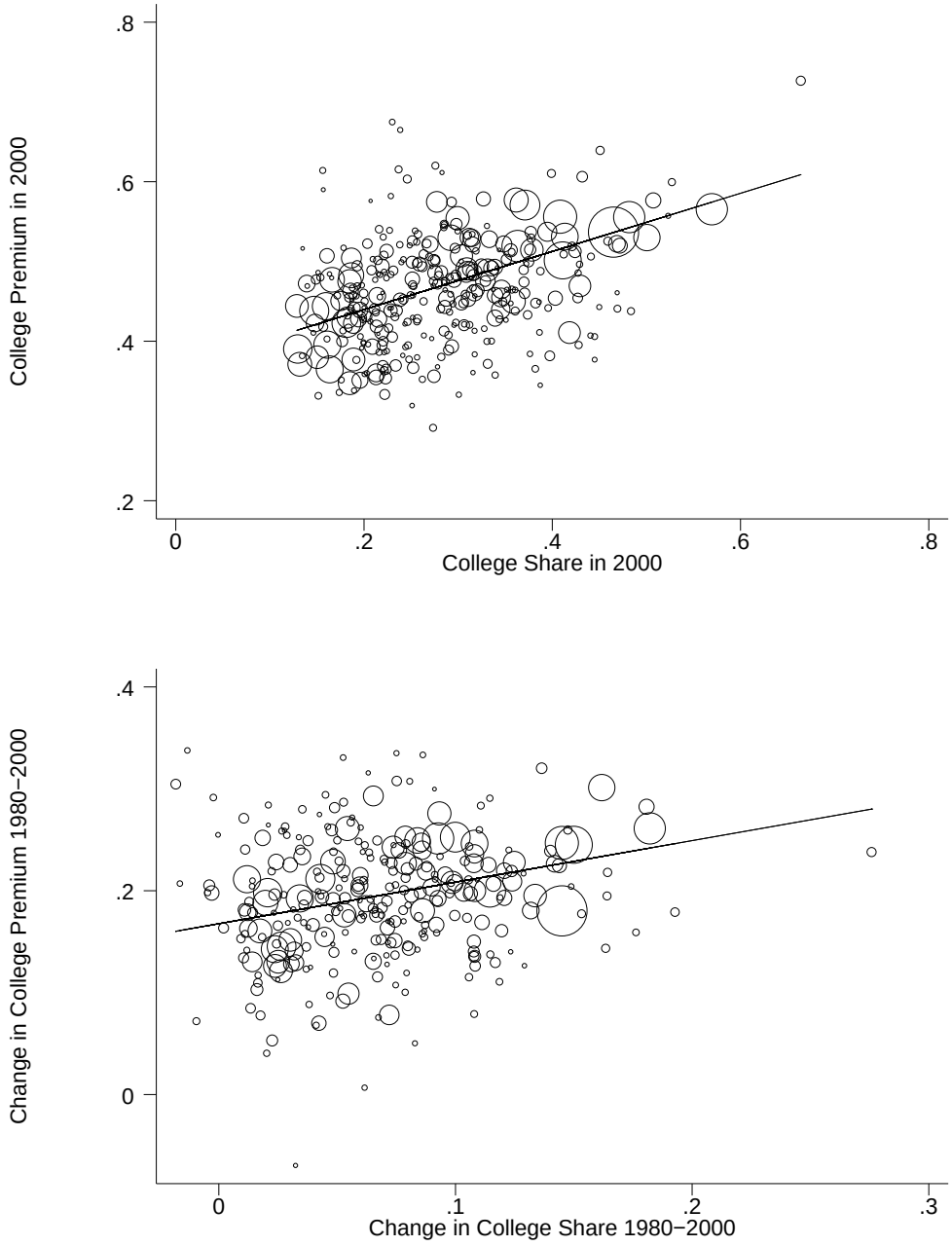
  - Demand pull $\rightarrow$ small increase in inequality in well-being

  - Supply push $\rightarrow$ larger increase in inequality in well-being

Demand or Supply? Two pieces of evidence

- First, I show the empirical relationship between the college share and the college premium across metropolitan areas
  - Demand pull would predict a positive slope
  - Supply push would predict zero slope
- Note: this relationship is <u>not</u> causal

Figure 3: Share of College Graduates and College Premium, by City



Notes: The top panel plots estimates of the city-specific college premium in 2000 against the share of college graduates in 2000. The bottom panel plots the 1980-2000 change in college premium against the 1980-2000 change in the share of college graduates.

Table 7: The Relation between Share of College Graduates and College Premium

	2000 Cross-section	1980-2000 Change	
	OLS	OLS	IV
	(1)	(2)	(3)
College Share	.375	.388	.371
	(.031)	(.070)	(.106)
R^2	.30	.10	

Notes: Standard errors in parentheses. The dependent variable in column 1 is the city-specific college premium, defined as the city-specific difference in the log of hourly wage for college graduates and high school graduates conditional on gender, a cubic in potential experience, race and year. The dependent variable in columns 2 and 3 is the change in the city-specific college premium. Entries are the coefficient on college share in column 1 and change in college share in columns 2 and 3. All models are weighted by city size.

- Second, I use observable shocks to the relative demand of skilled labor as an instrumental variable for college share.

- This IV estimate isolates the effect on the college premium of changes in the college share that are driven exclusively by changes in the relative demand.

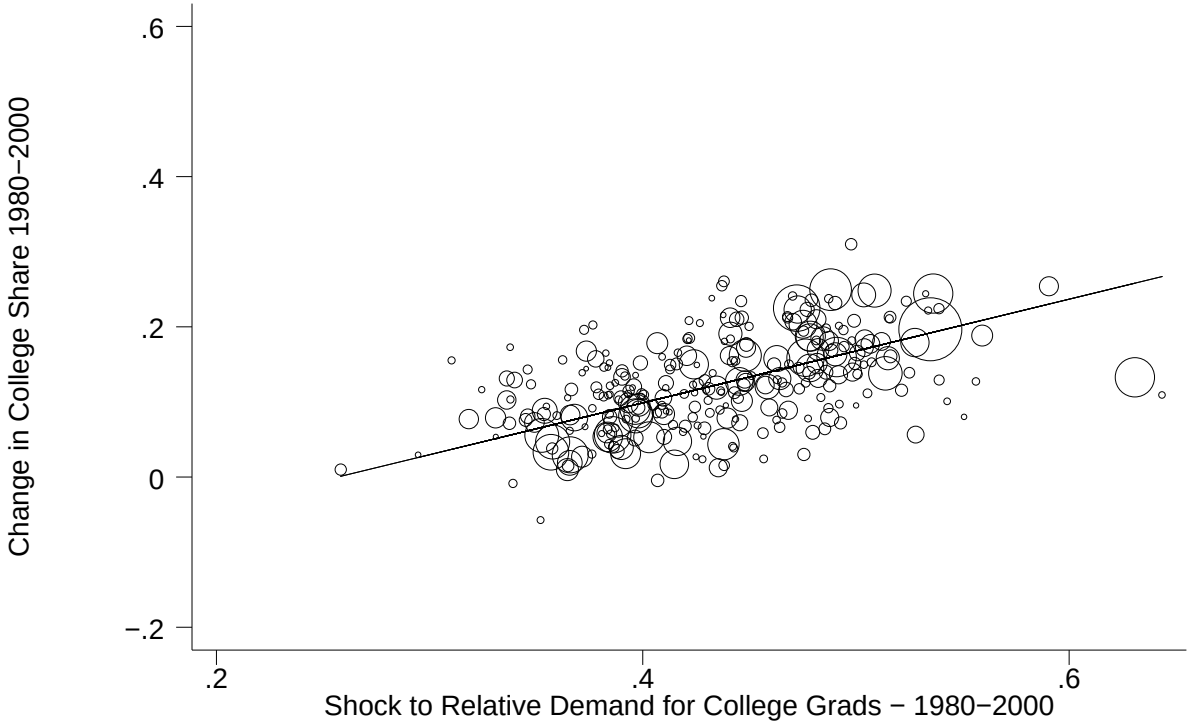
- Change in Relative Demand $= \sum_s \eta_{sc}(\Delta E_{Hs} - \Delta E_{Ls})$

  η_{sc} is the share jobs in industry s in city c in 1980

  ΔE_{Hs} is the nationwide 1980-2000 change in the log of number of jobs of college graduates in industry s excluding city c

  ΔE_{Ls} is similar change for high school graduates

Figure 4: Share of College Graduates and Relative Demand Shocks, by City



Notes: The panel plots changes in the share of college graduates 1980-2000 on the y-axis against 1980-2000 shocks to the relative demand of college graduates due to 1980 differences in industry mix on the x-axis. Shocks to the relative demand are defined in equation 16.

Role of Amenities

- My findings do not imply that amenities do not matter in absolute terms

- My findings imply that most of the changes over time in the geographical location of skilled workers relative to unskilled workers are driven by changes in the relative availability of jobs (rather than changes the relative desirability of amenities).

- It is still possible that amenities are important for geographical location of workers

Conclusions

- Over the past 25 years, college graduates have experienced higher inflation than high school graduates, mostly because of housing costs

- There is less wage inequality than we previously thought

    1. Real inequality is much smaller than nominal inequality

    2. Real inequality has grown much less

- Implications for inequality in well-being depend on why college graduates sort into expensive areas

- Empirical evidence indicates that most of the changes in the geographical location of skilled and unskilled workers are driven by relative demand shifts

- I conclude that inequality in well-being has increased less than nominal wage inequality.

  The problem of inequality is less severe than previously thought

What Causes Localized Relative Demand Shocks?

1. Localized SBTC. But it needs a theory of why demand shocks occur in some cities and not in others.

   - Human capital spillovers or agglomerations spillovers (Moretti, 2004a and 2004b; Greenstone, Hornbeck and Moretti, 2007)

   - Beaudry, Doms and Lewis (2008); Berry and Glaeser (2005)

2. Shifts in product demand across industries that have different skill intensities.

   Example: finance and high tech are located in expensive coastal metropolitan areas and have been expanding during the 1980s and 1990s.