Market Power and Wage Inequality

Shubhdeep Deb[1] Jan Eeckhout[1] Aseem Patel[2] Lawrence Warren[3]

[1]UPF Barcelona
[2]Essex
[3]US Census Bureau

University of Zurich

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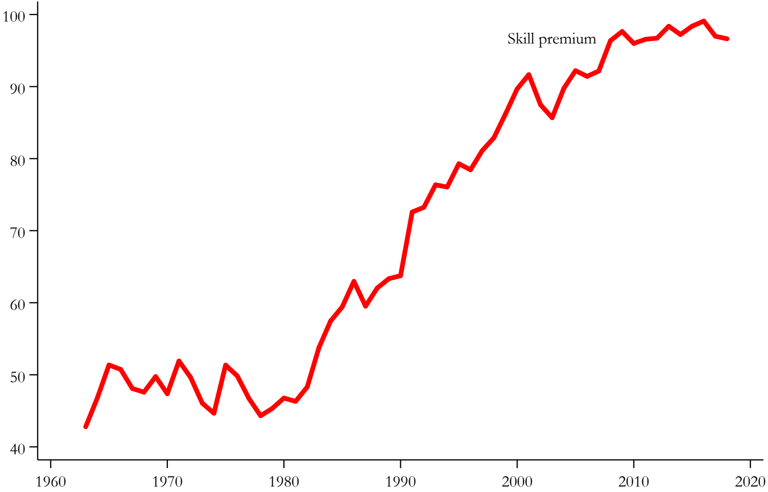
Motivation

Rising Wage Inequality since 1980



Motivation

1. Consensus: Due to Technological Change (Katz-Murphy)

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2. Since 1980: Rise of Market Power $\Rightarrow$ what is role of market power for wage inequality?
   - We want to understand and quantify the mechanism
   - Implications for welfare and policy
     1. Pure technological change in competitive markets is efficient
        $\rightarrow$ only role for redistributive policy – 2nd Welfare Thm
     2. If Market Power: efficiency-improving intervention – 1st Welfare Thm
        $\rightarrow$ How: intervene in product market? In labor market?

Motivation

Jointly estimate Technology and Market Structure to study change wage inequality:

- Technology is firm and skill-specific:
    1. Estimate distribution of productivities (not just aggregates)
    2. Distinguish between within vs between firm inequality
- Firms have market power
    1. Market Power in goods market + labor market (rent sharing)
    2. Number of competitors as residual

Main Insights

1. Market Power
   - Increases Skill Premium by 13%
   - Contributes 52% to increase in between-firm variance in wages
   - Lowers Wage level by more than 10% (without technological regress)
     → Decline in labor share is GE effect
2. Heterogeneity in firm-level TFP: explains the rest (and interacts with market power)
3. Welfare Cost: 8%
   → Reducing Inequality (via reduction in market power) is Pareto efficient

Supply-Demand Framework: Katz-Murphy

- Representative firm: firm = aggregate

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

  where σ is the elasticity of substitution

- FOCs: profit maximization given competitive markets gives skill premium:

$$\frac{W_H}{W_L} = \left(\frac{A_H}{A_L}\right)^{\frac{\sigma-1}{\sigma}} \left(\frac{H}{L}\right)^{\frac{\sigma-1}{\sigma}-1} \quad \Rightarrow \quad \ln\left(\frac{W_H}{W_L}\right) = \frac{\sigma-1}{\sigma}\ln\left(\frac{A_H}{A_L}\right) - \frac{1}{\sigma}\ln\left(\frac{H}{L}\right)$$

- Only explanation, Skill Biased Technological Change: $\frac{A_H}{A_L} \uparrow$

  $\rightarrow$ Additions: polarization (Acemoglu-Autor) and capital intensity (KORV)

The Model Setup

Environment Static Economy.

- Representative Household
- Markets: $i \in I$ goods; $n \in N$ firms; $j \in J$ markets
- Two types of skilled workers: L_{inj}, H_{inj}

Preferences Household has preferences over consumption and labor supply

- Imperfect substitution, double-nested CES: more substitutable within market than between
  - Consumption (Atkeson-Burstein): $\eta > \theta$
  - Labor (Berger-Herkenhoff-Mongey): $\hat{\eta}_H > \hat{\theta}_H$ and $\hat{\eta}_L > \hat{\theta}_L$
  - Assumption: same market definition for goods and labor
- Π: aggregate profits are distributed lump-sum to household

The Model Setup

Preferences Household maximizes static utility:

$$\max_{C_{inj},L_{inj},H_{inj}} U\left(C - \frac{1}{\bar{\phi}_L}\frac{L^{\frac{\phi_L+1}{\phi_L}}}{\frac{\phi_L+1}{\phi_L}} - \frac{1}{\bar{\phi}_H}\frac{H^{\frac{\phi_H+1}{\phi_H}}}{\frac{\phi_H+1}{\phi_H}}\right) \quad \text{s.t. } PC = LW_L + HW_H + \Pi$$

- P, Y, C, L, H, W_L, W_H: Price, Output, Consumption, Employment and Wage indices
- Consumption and labor more substitutable within market η than between θ : $\eta > \theta$

$$C = \left(\int_j J^{-\frac{1}{\theta}} C_j^{\frac{\theta-1}{\theta}} dj\right)^{\frac{\theta}{\theta-1}} \quad , \quad C_j = \left(\sum_{i,n} I^{-\frac{1}{\eta}} C_{inj}^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}}$$

$$L = \left(\int_j J^{\frac{1}{\hat{\theta}_L}} L_j^{\frac{\hat{\theta}_L+1}{\hat{\theta}_L}} dj\right)^{\frac{\hat{\theta}_L}{\hat{\theta}_L+1}} \quad , \quad L_j = \left(\sum_{i,n} I^{\frac{1}{\hat{\eta}_L}} L_{inj}^{\frac{\hat{\eta}_L+1}{\hat{\eta}_L}}\right)^{\frac{\hat{\eta}_L}{\hat{\eta}_L+1}}$$

$$H = \left(\int_j J^{\frac{1}{\hat{\theta}_H}} H_j^{\frac{\hat{\theta}_H+1}{\hat{\theta}_H}} dj\right)^{\frac{\hat{\theta}_H}{\hat{\theta}_H+1}} \quad , \quad H_j = \left(\sum_{i,n} I^{\frac{1}{\hat{\eta}_H}} H_{inj}^{\frac{\hat{\eta}_H+1}{\hat{\eta}_H}}\right)^{\frac{\hat{\eta}_H}{\hat{\eta}_H+1}}$$

The Model Setup

Technology

$$Y_{inj} = \left[\left(A_{Linj} L_{inj} \right)^{\frac{\sigma-1}{\sigma}} + \left(A_{Hinj} H_{inj} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

where:

- A_{Hinj}, A_{Linj}: firm-specific productivity, from joint distribution $G(A_{Hinj}, A_{Linj})$

Market Structure

In each market j, N firms Cournot compete (similar results with Bertrand competition)

Equilibrium Solution

Household Optimality: goods demand and labor supply satisfy

$$C_{inj} = \frac{1}{J}\frac{1}{I}P_{inj}^{-\eta}P_j^{\eta-\theta}P^{\theta}C$$
$$L_{inj} = \frac{1}{J}\frac{1}{I}W_{Linj}^{\hat{\eta}_L}W_{Lj}^{\hat{\theta}_L-\hat{\eta}_L}W_L^{-\hat{\theta}_L}L$$
$$H_{inj} = \frac{1}{J}\frac{1}{I}W_{Hinj}^{\hat{\eta}_H}W_{Hj}^{\hat{\theta}_H-\hat{\eta}_H}W_H^{-\hat{\theta}_H}H$$

Equilibrium Solution

Producer Optimality

- The firm maximizes profits (with strategic interaction in oligopolistic markets)

$$\Pi_{inj} = \max_{H_{inj}, L_{inj}} P_{inj}(Y_{inj}, Y_{-inj})Y_{inj} - W_{Hinj}(H_{inj}, H_{-inj})H_{inj} - W_{Linj}(L_{inj}, L_{-inj})L_{inj}$$

- The first order conditions for H_{inj} (similar for L_{inj}):

$$Y_{ij}^{\frac{1}{\sigma}} A_{H,inj}^{\frac{\sigma-1}{\sigma}} H_{inj}^{-\frac{1}{\sigma}} P_{inj}(Y_{inj}) \left[1 + \varepsilon_{inj}^{P}\right] = W_{Hinj} \left[1 + \varepsilon_{inj}^{H}\right]$$

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where

$$\varepsilon_{inj}^{P} = -\left[\frac{1}{\theta} s_{nj} + \frac{1}{\eta}(1 - s_{nj})\right]; \quad \varepsilon_{inj}^{H} = \frac{1}{\hat{\theta}_H} e_{Hnj} + \frac{1}{\hat{\eta}_H}(1 - e_{Hnj}); \quad \varepsilon_{inj}^{L} = \frac{1}{\hat{\theta}_L} e_{Lnj} + \frac{1}{\hat{\eta}_L}(1 - e_{Lnj})$$

$$\mu_{inj} = \frac{1}{1 + \varepsilon_{inj}^{P}}; \qquad \delta_{inj}^{H} = 1 + \varepsilon_{inj}^{H}; \qquad \delta_{inj}^{L} = 1 + \varepsilon_{inj}^{L}$$

Equilibrium Solution

Relative FOCs

$$\ln\left(\frac{W_{Hinj}}{W_{Linj}}\right) = \underbrace{\ln\left(\frac{1+\varepsilon^{L}_{inj}}{1+\varepsilon^{H}_{inj}}\right)}_{\text{Rent Sharing}} + \underbrace{\frac{\sigma-1}{\sigma}\ln\left(\frac{A_{Hinj}}{A_{Linj}}\right)}_{\text{Firm Technology}} - \underbrace{\frac{1}{\sigma}\ln\left(\frac{H_{inj}}{L_{inj}}\right)}_{\text{Firm Labor D}}$$

- Holds at the firm level
- Need to aggregate and derive general equilibrium prices and wages.

Identical Firms

Analytical Solution

- Skill Premium in the homogeneous case can be written as

$$\kappa = \left[\left(\frac{A_H}{A_L} \right)^{\frac{\sigma-1}{\sigma+\phi}} \cdot \left(\frac{\bar{\phi}_L}{\bar{\phi}_H} \right)^{\frac{\phi}{\sigma+\phi}} \right] \cdot \left[\frac{1 + \frac{1}{\hat{\theta}_L}\frac{1}{N} + \frac{1}{\hat{\eta}_L}(1 - \frac{1}{N})}{1 + \frac{1}{\hat{\theta}_H}\frac{1}{N} + \frac{1}{\hat{\eta}_H}(1 - \frac{1}{N})} \right]^{\frac{\sigma}{\sigma+\phi}}$$

- Then

$$\frac{\partial \kappa}{\partial N}\frac{N}{\kappa} = \frac{\sigma}{\sigma+\phi} \frac{N \left[\left(1 + \frac{1}{\hat{\eta}_L}\right)\left(\frac{1}{\hat{\theta}_H} - \frac{1}{\hat{\eta}_H}\right) - \left(1 + \frac{1}{\hat{\eta}_H}\right)\left(\frac{1}{\hat{\theta}_L} - \frac{1}{\hat{\eta}_L}\right) \right]}{\left[N\left(1 + \frac{1}{\hat{\eta}_H}\right) + \frac{1}{\hat{\theta}_H} - \frac{1}{\hat{\eta}_H} \right] \left[N\left(1 + \frac{1}{\hat{\eta}_L}\right) + \frac{1}{\hat{\theta}_L} - \frac{1}{\hat{\eta}_L} \right]}.$$

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$$\kappa = \left[\left(\frac{A_H}{A_L} \right)^{\frac{\sigma-1}{\sigma+\phi}} \cdot \left(\frac{\bar{\phi}_L}{\bar{\phi}_H} \right)^{\frac{\phi}{\sigma+\phi}} \right] \cdot \left[\frac{1 + \frac{1}{\hat{\theta}_L} \frac{1}{N} + \frac{1}{\hat{\eta}_L}(1 - \frac{1}{N})}{1 + \frac{1}{\hat{\theta}_H} \frac{1}{N} + \frac{1}{\hat{\eta}_H}(1 - \frac{1}{N})} \right]^{\frac{\sigma}{\sigma+\phi}}$$

- Then

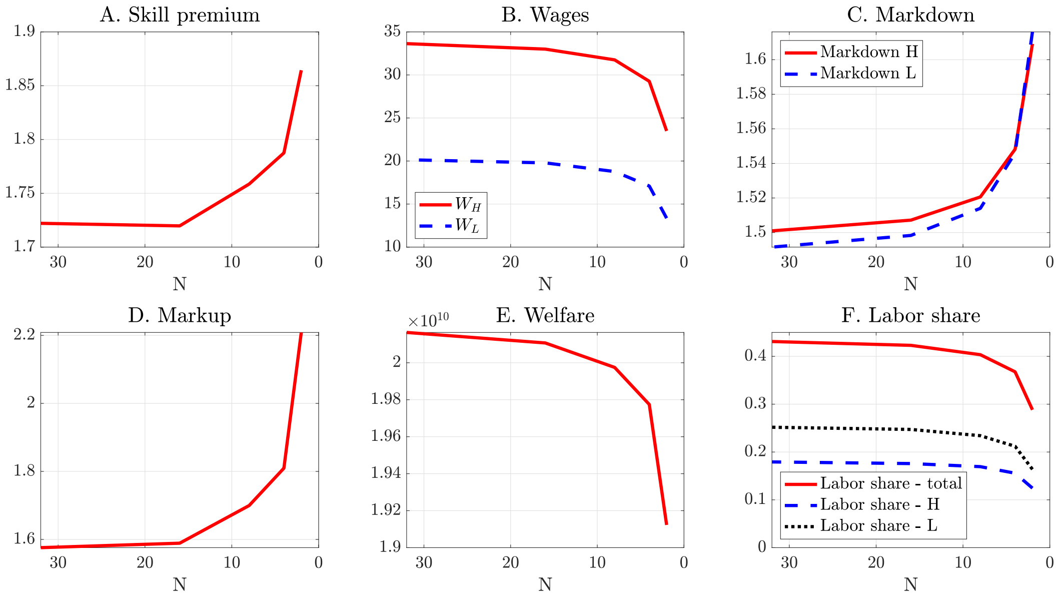
$$\frac{\partial \kappa}{\partial N} \frac{N}{\kappa} = \frac{\sigma}{\sigma + \phi} \frac{N \left[\left(1 + \frac{1}{\hat{\eta}_L}\right) \left(\frac{1}{\hat{\theta}_H} - \frac{1}{\hat{\eta}_H} \right) - \left(1 + \frac{1}{\hat{\eta}_H}\right) \left(\frac{1}{\hat{\theta}_L} - \frac{1}{\hat{\eta}_L} \right) \right]}{\left[N \left(1 + \frac{1}{\hat{\eta}_H}\right) + \frac{1}{\hat{\theta}_H} - \frac{1}{\hat{\eta}_H} \right] \left[N \left(1 + \frac{1}{\hat{\eta}_L}\right) + \frac{1}{\hat{\theta}_L} - \frac{1}{\hat{\eta}_L} \right]}.$$

- Skill premium is increasing in market power $\frac{\partial \kappa}{\partial N} \frac{N}{\kappa} < 0$ if

$$\hat{\eta}_H < \hat{\eta}_L \quad \text{and} \quad \frac{1}{\hat{\theta}_H} - \frac{1}{\hat{\eta}_H} < \frac{1}{\hat{\theta}_L} - \frac{1}{\hat{\eta}_L}$$

Comparative Statics

Change in Market Structure N



Quantitative Exercise

Data

- Census Data: merge LBD (revenue) with LEHD (education, employment, earnings):
  - we attach firm-level information on skills from LEHD to establishment in LBD

- In the data we observe
  1. Employment (in hours, at firm level) by Skill: L_{inj}, H_{inj}
  2. Wages by Skill W_{Linj}, W_{Hinj}
  3. Revenue: R_{inj}

- Market structure is unobserved
  - Stochastic notion of market structure, consistent with the model
  - Randomly assign establishments within NAICS$\times$Geo sector

  $\Rightarrow$ Market structure is like Solow residual for TFP

Quantitative Exercise

Estimation

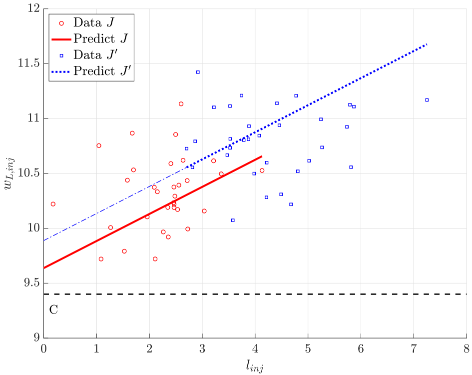
	Input/data	Output	
1. Common elasticities	W_{Hinj}, W_{Linj}	$\hat{\theta}, \hat{\eta}$	
2. Firm-specific technology	H_{inj}, L_{inj}	A_{Hinj}, A_{Linj}	system of FOCs given N
3. Market Structure	R_{inj}	N	

Externally Set Parameters

Variable	Value	Description	Source
θ	1.30	Between sector elasticity	DeLoecker et al (2021)
η	5.75	Within sector elasticity	DeLoecker et al (2021)
σ	2.94	Elasticity of substitution	Acemoglu and Autor (2011)
ϕ_H	0.25	Supply elasticity (High)	Chetty et al. (2011)
ϕ_L	0.25	Supply elasticity (Low)	Chetty et al. (2011)

Estimated Elasticities

$$w_{inj} = \underbrace{-\frac{1}{\hat{\theta}} log\left(\frac{1}{J}\right) \quad -\frac{1}{\hat{\eta}} log\left(\frac{1}{I}\right) \quad -\frac{1}{\hat{\theta}} I + w}_{C} \quad + \underbrace{\left(\frac{1}{\hat{\theta}} - \frac{1}{\hat{\eta}}\right) l_j}_{C_j} + \frac{1}{\hat{\eta}} l_{inj}$$



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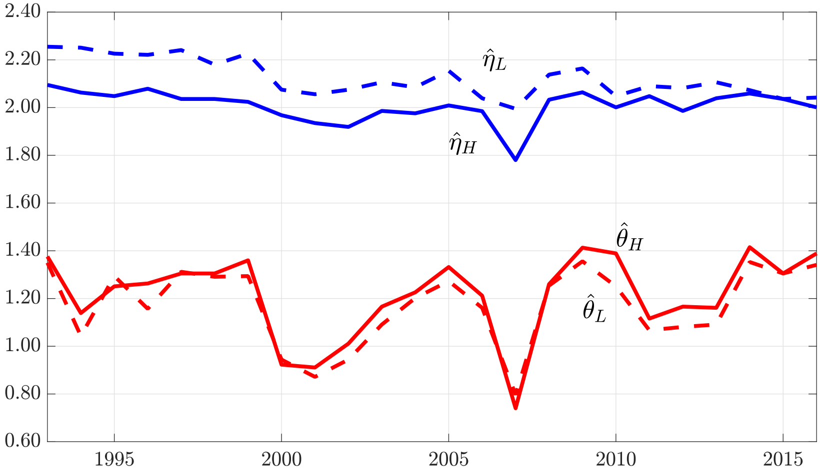
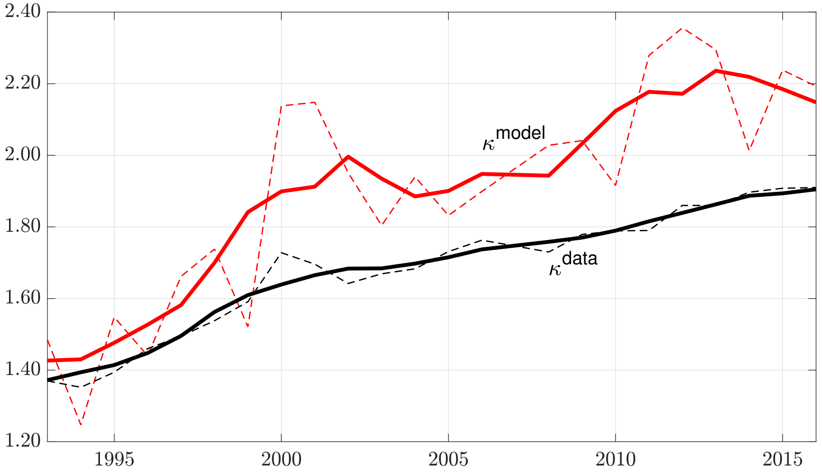
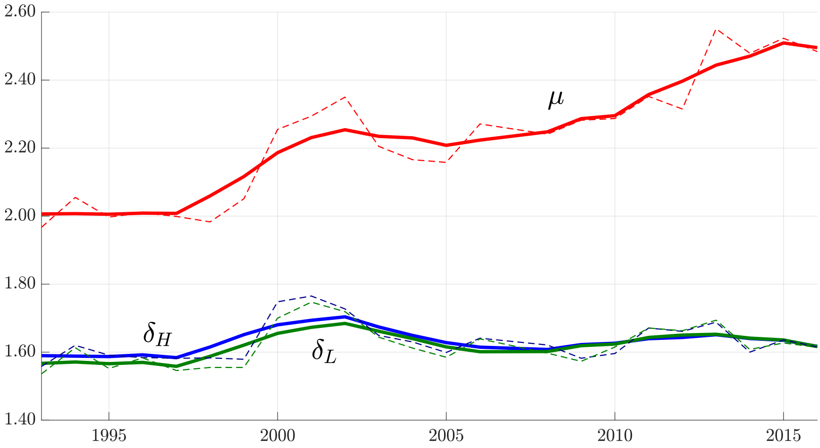
Estimated Labor Supply Elasticities



Skill Premium Evolution

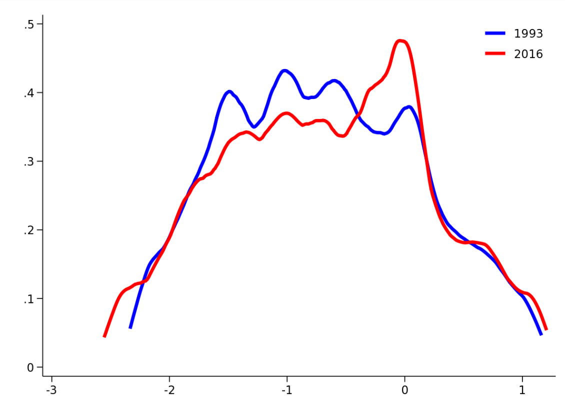


Market Power



Estimated Firm-specific Technology A_{Hinj}, A_{Linj}

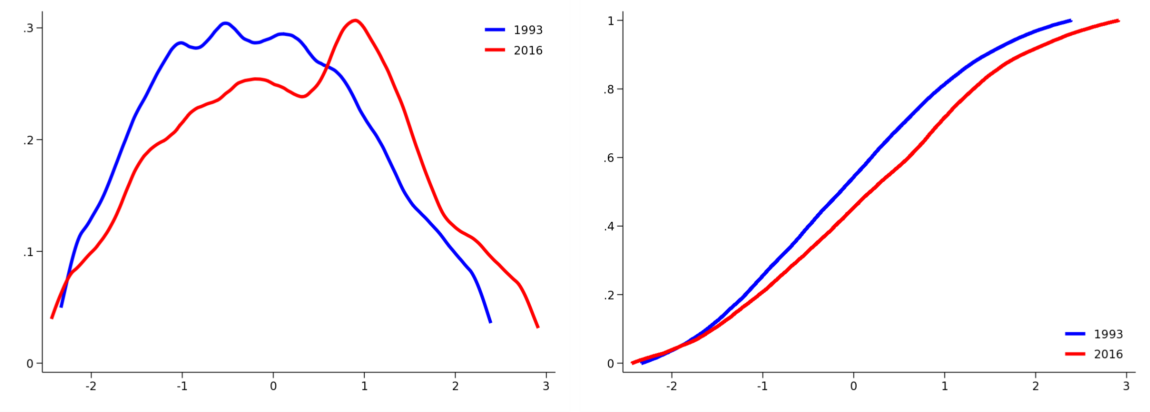
Input – Data: $\ln \frac{H_{inj}}{L_{inj}}$



- Variance (in levels; weighted): from 5 (1993) to 21 (2016)
  $\rightarrow$ evidence of increased between-firm inequality

Estimated Distributions

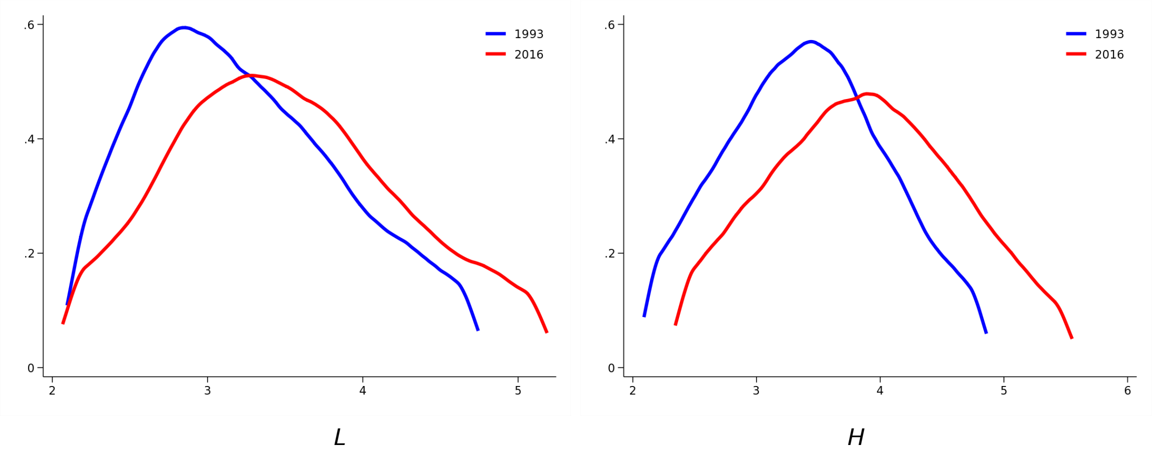
Technology $\ln \frac{A_{Hinj}}{A_{Linj}}$



- First-Order Stochastic Dominance: Evidence of Skill-Biased Technological Change
- Variance (levels; weighted): from 5 (1993) to 7200 (2016) $\rightarrow$ between-firm variance $\uparrow$

Backed Out Distributions

Marginal Product in \$: $ln\left(P_{inj}\frac{\partial Y_{inj}}{\partial H_{inj}}\right)$ and $ln\left(P_{inj}\frac{\partial Y_{inj}}{\partial L_{inj}}\right)$



Counterfactual Economies

Decomposition

		1993 $\to$ 2016				
	2016 value	**Skill Premium**		**Welfare**	W_H	W_L
		Ratio	**% Contr.**			
1993		1.48	0%	100.0	100.0	100.0
	N	1.51	5.0%	98.3	91.1	89.6
	$\{\hat{\eta}, \hat{\theta}\}$	1.53	8.8%	97.5	98.9	95.7
	$N, \{\hat{\eta}, \hat{\theta}\}$	1.56	12.9%	95.9	90.1	85.9
	A	2.11	105.2%	209.1	228.1	160.4
	$N, \{\hat{\eta}, \hat{\theta}\}, A$	2.32	140.2%	193.4	181.3	115.8
2016	$N, \{\hat{\eta}, \hat{\theta}\}, A$, Lab Sup	2.08	100.0%	265.3	167.9	119.8

Counterfactual Economies

Inequality: Variance Decomposition

1993 → 2016							
	2016 value	In Levels			In Percentage Terms		
		Total	Within	Between	Total	Within	Between
1993		0.80	0.07	0.73	0.0%	0.0%	0.0%
	N	0.83	0.07	0.76	19.5%	2.5%	27.7%
	$\{\hat{\eta}, \hat{\theta}\}$	0.83	0.07	0.76	17.3%	5.0%	23.2%
	$N, \{\hat{\eta}, \hat{\theta}\}$	0.86	0.07	0.79	37.7%	7.0%	52.4%
	A	0.92	0.12	0.80	81.5%	108.9%	68.3%
	$N, \{\hat{\eta}, \hat{\theta}\}, A$	1.01	0.13	0.88	139.8%	120.2%	149.7%
2016	$N, \{\hat{\eta}, \hat{\theta}\}, A$, Lab Sup	0.95	0.12	0.83	100.0%	100.0%	100.0%

Conclusion

- Main Findings:
  - Market Power contributes
    1. 13% to increase in Skill Premium
    2. 52% to increase in between-firm wage inequality

    → Market Power main determinant of between-firm wage inequality
  - Technology: the rest, both mean (Katz-Murphy) and variance
  - Large GE effect on wage Level: more than 10% drop (decline in labor share)

    Resolve puzzle: decline in low skilled wages is not due to technological regress
  - Welfare: 8% decline

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    Resolve puzzle: decline in low skilled wages is not due to technological regress
  - Welfare: 8% decline

- Why do we care?

  Large welfare loss:
  - Wage inequality is Pareto inefficient (1st welfare theorem fails)

    → Policies that reduce market power affect wage inequality
  - If inefficiency is addressed, less need to redistribute on equity grounds (2nd welfare theorem)

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[1]UPF Barcelona
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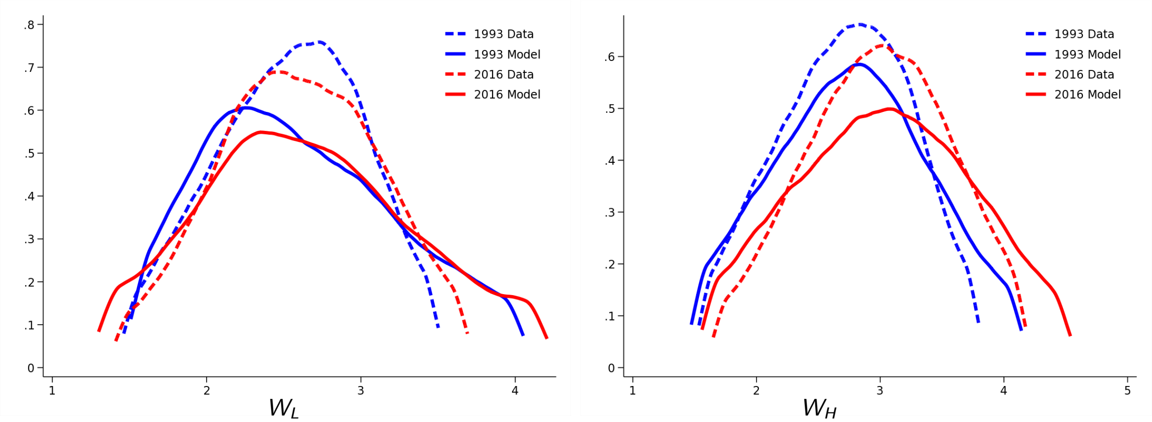
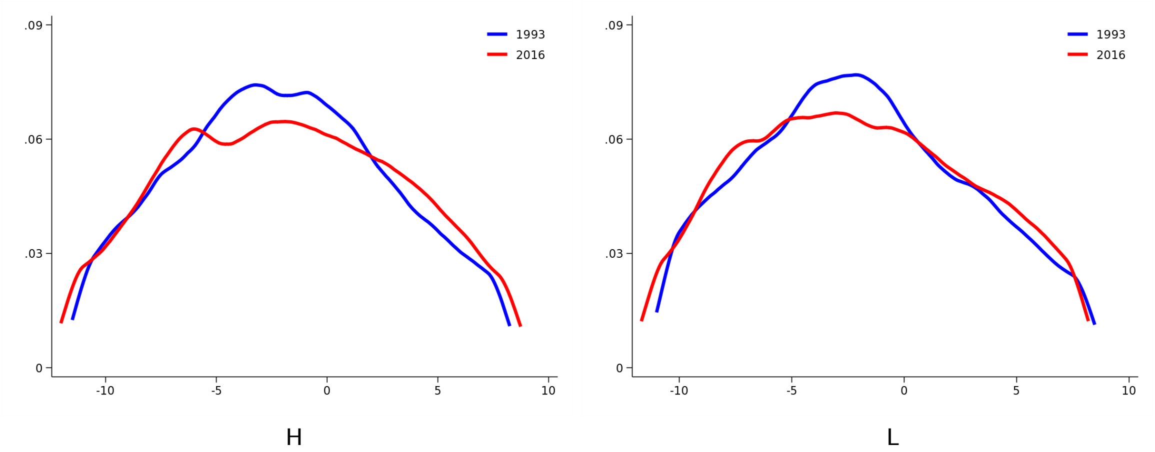
Model Fit : Wage Distribution



Estimated Distributions

Technology $\ln A_{Linj}$, $\ln A_{Hinj}$



Estimation

Labour Supply Elasticities

To estimate the supply elasticities and disutility shifter, we rely on the inverse supply function:

$$\ln W^*_{Sinj} = \underbrace{c + \left(\frac{1}{\hat{\theta}_S} - \frac{1}{\hat{\eta}_S}\right)\ln S_j + \frac{1}{\hat{\eta}_S}\ln S_{inj}}_{\text{Model}} + \underbrace{\epsilon_{Sinj}}_{\text{Measurement error}}$$

where

$$c = \ln \bar{\phi}_S^{-1} J^{\hat{\theta}_S} I^{\hat{\eta}_S} - \left(\frac{1}{\hat{\theta}_S} - \frac{1}{\phi_S}\right)\ln S$$

Key identifying assumptions:

$$\mathbb{E}(\epsilon_{Sinj}) = 0, \quad \mathbb{E}(\ln S_{inj} \times \epsilon_{Sinj}) = 0$$

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Estimation

A Three-Step Procedure

Step 1: Estimate within-market elasticity, $\hat{\eta}_S$, using the within-estimator:

$$\underbrace{\ln W^*_{Sinj} - \overline{\ln W^*_{Sj}}}_{\ln \tilde{W^*}_{Sinj}} = \frac{1}{\hat{\eta}_S}(\underbrace{\ln S_{inj} - \overline{\ln S_j}}_{\ln \tilde{S}_{inj}}) + (\epsilon_{Sinj} - \overline{\epsilon_{Sj}})$$

Step 2: Estimate between-market elasticity, $\hat{\theta}_S$, using OLS

$$\ln W^*_{Sinj} - \frac{1}{\hat{\eta}_S}(\ln S_{inj} - \ln S_j) = \mathrm{c} + \frac{1}{\hat{\theta}_S} \ln S_j + \epsilon_{Sinj}$$

Step 3: Retrieve the labor supply disutility parameter, $\bar{\phi}_S$, as follow

$$\bar{\phi}_S = \exp\left[\mathrm{c} + \left(\frac{1}{\hat{\theta}_S} - \frac{1}{\phi_S}\right) \ln S - \ln J^{\hat{\theta}_S} I^{\hat{\eta}_S}\right]^{-1}$$

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Identification

A mapping between structural parameters and data moments

The within-market elasticity is identified as follows

$$\hat{\eta}_S = \left[\frac{\mathbb{C}ov(\ln \tilde{S}_{inj}, \ln \tilde{W^*}_{Sinj})}{\mathbb{V}ar(\ln \tilde{S}_{inj})} \right]^{-1}$$

The between-market elasticity is identified as follows

$$\hat{\theta}_S = \left[\frac{\mathbb{C}\text{ov}(\ln S_j, \ln W^*_{Sinj} - \frac{1}{\hat{\eta}_S}(\ln S_{inj} - \ln S_j))}{\mathbb{V}\text{ar}(\ln S_j)} \right]^{-1}$$

The labor disutility shifter is identified as follows

$$\bar{\phi}_S = \exp\left[\text{c} + \left(\frac{1}{\hat{\theta}_S} - \frac{1}{\phi_S} \right) \ln S - \ln J^{\hat{\theta}_S} I^{\hat{\eta}_S} \right]^{-1}$$

where c is calculated as:

$$\text{c} = \mathbb{E}\left[\ln W^*_{Sinj} - \frac{1}{\hat{\eta}_S}(\ln S_{inj} - \ln S_j) \right] - \frac{1}{\hat{\theta}_S}\mathbb{E}[\ln S_j]$$

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Simulation Results

The results are for an economy with $J = 400$ and $I = 32$

We draw the market-specific mean of firm productivity from: $\mathbb{N}(0, 25)$

Within-sector variance of firm productivity is identical across sectors

Table: Simulation results

	$\hat{\eta}_S$	$\hat{\theta}_S$	$\bar{\phi}_S$	$\hat{\eta}_S$	$\hat{\theta}_S$	$\bar{\phi}_S$
	$\epsilon_{Sinj} \sim N(0, 0.2)$			$\epsilon_{Sinj} \sim N(0, 2)$		
True Value	2.00	1.50	10.00	2.00	1.50	10.00
OLS	1.99	1.49	9.99	1.99	1.48	9.98
NLS	2.00	1.49	9.96	2.00	1.48	9.88
GMM*	1.95	1.50	10.05	2.00	1.48	9.77

* Moments: $\mathbb{E}(\epsilon_{Hinj}) = 0, \quad \mathbb{E}(\epsilon_{Hinj} \ln H_{inj}) = 0, \quad \mathbb{E}(\epsilon_{Hinj}\mathbb{E}(\ln H_{-inj})) = 0$

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Difference between NLS and GMM

Consider a model

$$Y_i = g(X_i, \beta) + \epsilon_i$$

where we assume that

$$\mathbb{E}(Y_i | X_i = x) = g(x, \beta), \quad \mathbb{E}(\epsilon_i) = 0$$

NLS estimates β using the following moment

$$\min_{\beta} \sum_{i=1}^{N} \epsilon_i^2 = \min_{\beta} \left[\sum_{i=1}^{N} \Big(Y_i - g(X_i, \beta) \Big)^2 \right] \implies \mathbb{E}\left[\frac{\partial g(X_i, \beta)}{\partial \beta} \underbrace{[Y_i - g(X_i, \beta)]}_{\epsilon_i} \right] = 0$$

GMM estimates β using the following moment

$$\mathbb{E}(X_i \epsilon_i) = 0 \implies \mathbb{E}\left[X_i \underbrace{[Y_i - g(X_i, \beta)]}_{\epsilon_i} \right] = 0$$