The Distribution of Labor Market Surplus

Davide Alonzo (U. de Montreal)

Giovanni Gallipoli (UBC, Vancouver)

Motivation

- Large shifts in both *employment* and *wages* post 1980

  (a) Skilled workers: growing headcounts and returns
  Katz and Murphy (1992); Katz and Autor (1999); Beaudry, Green and Sand (2016)

  (b) Shrinking share of middle-paying occupations
  Acemoglu and Autor (2011)

  (c) Rising presence of women in high paying occupations
  Cortes, Jaimovich and Siu (2018)

  (d) Shrinking labor supply of young men
  Aguiar et al. (2021)

- **How to account for these patterns?**

  - *Technological change:* Productivity changes across occupations.
  - *Non-pecuniary returns:* Some occupations more desirable for some workers.
  - *Equilibrium effects:* Interaction of technology and non-pecuniary aspects.

  $\Rightarrow$ Focus on evolution of labor market surplus: **recover distributions of pecuniary and non-pecuniary components of surplus**

What We Do

1 Simple equilibrium model of labor market

- **Two-sided heterogeneity** ($\Rightarrow$ worker-occupation matches)
- Workers choose jobs
- Heterogeneous firms demand different occupations to produce

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   - **Two-sided heterogeneity** ($\Rightarrow$ worker-occupation matches)
   - Workers choose jobs
   - Heterogeneous firms demand different occupations to produce
2. Recover estimates of:
   - **Labor demand**
     - $\Rightarrow$ Technology parameters (productivity and substitutability of occupation inputs)
   - **Labor supply** (intensive and extensive margins)
     - $\Rightarrow$ Rents (inframarginal occupation choice)
     - $\Rightarrow$ Compensating differentials (marginal occupation choice)
   - **Match surplus for different worker-occupation pairs** (pecuniary and non-pecuniary components)

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3 Findings:

1. Non-pecuniary surplus important to account for employment shifts
2. Technological change drives wages
3. Compensating differentials and rents have grown significantly since the 1980s
4. The distribution of rents have become more concentrated

Model

Model: Labor Supply I

- In each period t, continuum of workers populate M geographically segmented markets
  - I types of workers
  - Each worker chooses one of J occupations (or non-employment)

$$\max_{j=0,1,..,J} U_{ijmt} + \theta_j^{\iota}$$

  - U_{ijmt}: **systematic** return for type i in occupation j
  - $\theta_j^{\iota} \sim$ Type I Extreme Value: **idiosyncratic (non-systematic)** preference of ι worker
- Mass of workers choosing occupation j is μ_{ijmt}

Model: Labor Supply II

- **Systematic return** associated with match (i,j) in market-period (m,t) :

$$U_{ijmt} = \max_{h_{ijmt}} \overbrace{\frac{c_{ijmt}^{1-\sigma}-1}{1-\sigma}}^{\text{Consumption}} - \overbrace{\psi_i \frac{h_{ijmt}^{1-\gamma}}{1-\gamma}}^{\text{Hours Worked}} + \overbrace{b_{ijt}}^{\text{Non-pecuniary Component}}$$

$$\text{s.t.} \quad c_{ijmt} = w_{ijmt} h_{ijmt} + y_{imt}$$

where y_{imt} is non-labor income

- **Systematic surplus**

$$S_{ijmt} = U_{ijmt} - U_{i0mt}$$

Model: Production I

- In each market, a final good is produced using a continuum of intermediate goods

$$\max_{\{\lambda_{jmtv}\}} \quad P_{mt}Y_{mt} - \int_v p_{jmtv}\lambda_{jmtv}dv$$

$$\text{s.t.} \quad Y_{mt} = \left(\int_v \lambda_{jmtv}^{\rho}dv\right)^{\frac{1}{\rho}}$$

where

$$P_{mt} = \left(\int_v p_{jmtv}^{\frac{-\rho}{1-\rho}}dv\right)^{\frac{-(1-\rho)}{\rho}}$$

- The first order condition gives

$$p_{jmtv} = \left[\frac{\lambda_{jmtv}}{Y_{mt}}\right]^{-(1-\rho)} P_{mt}$$

Model: Production II

- Each intermediate good is produced by a firm
- Each intermediate firm utilizes one occupation as input

$$\max_{p_{jmtv},\lambda_{jmtv},L_{ijmtv}} \quad p_{jmtv}\lambda_{jmtv} - \sum_i \tilde{w}_{ijmt} L_{ijmtv}$$

$$\text{s.t.} \quad \lambda_{jmtv} = z_{jmtv} \sum_i \beta_{ij} L_{ijmtv}$$

$$p_{jmtv} = \left[\frac{\lambda_{jmtv}}{Y_{mt}}\right]^{-(1-\rho)} P_{mt}$$

where $z_{jtv} \sim F_{jt}(v)$.

- Profits for each firm are

$$\pi_{jmtv} = \frac{1-\rho}{\rho} \sum_i \tilde{w}_{ijmt} L_{ijmtv}$$

- **Equilibrium:** $L_{ijmt} = \int_{v \in V_j} L_{ijmtv} dv = \mu_{ijmt} h_{ijmt}$

Data and Estimation

Data

- 1980, 1990 and 2000 Census; 2010 and 2018 ACS samples
- Define *ijmt* cells
  - i defined over gender, age and education (12 groups)
  - j is one of 13 Occupations
  - m is one of the four census regions: Northeast, Midwest, South, West
- Variables:
  - μ_{ijmt} mass of workers within cell
  - w_{ijmt} average hourly wage within cell
  - h_{ijmt} average hours worked within cell
  - y_{imt} average non-labor income (from business and farm) within cell

Estimation of Labor Supply: Intensive Margin

- We jointly estimate intensive and extensive margins of labor supply through GMM
- FONC for (intensive) labor supply has no closed-form solution
- Implicitly defines

$$\log\left(h_{ijmt}\right) = f\left(\boldsymbol{X}_{ijmt}, \tilde{\boldsymbol{\Omega}}_i\right)$$

where $\boldsymbol{X}_{ijmt} = [w_{ijmt};\ y_{imt}]$ and $\tilde{\boldsymbol{\Omega}}_i = [\sigma;\ \gamma;\ \psi_i]$.

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$$\log\left(h_{ijmt}\right) = f\left(\boldsymbol{X}_{ijmt}, \tilde{\boldsymbol{\Omega}}_i\right) + \epsilon^1_{ijmt}$$

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where $\boldsymbol{X}_{ijmt} = [w_{ijmt};\ y_{imt}]$ and $\tilde{\boldsymbol{\Omega}}_i = [\sigma;\ \gamma;\ \psi_i]$.

- We get the following moment conditions

$$E\left[\log\left(h_{ijmt}\right) - f\left(\boldsymbol{X}_{ijmt}, \tilde{\boldsymbol{\Omega}}_i\right) | i\right] = 0$$
$$E\left[\left(\log\left(h_{ijmt}\right) - f\left(\boldsymbol{X}_{ijmt}, \tilde{\boldsymbol{\Omega}}_i\right)\right) \boldsymbol{Z}^1_{ijmt}\right] = 0$$

where $\boldsymbol{Z}^1_{ijmt}$ is a vector of instruments.

Estimation of Labor Supply: Extensive Margin

- From multinomial logit structure of occupational choice

$$\log\left(\frac{\mu_{ijmt}}{\mu_{i0mt}}\right) = \frac{U_{ijt}(w_{ijmt}, y_{imt}) - U_{i0t}(0, y_{imt})}{\sigma_\theta}$$

Estimation of Labor Supply: Extensive Margin

- From multinomial logit structure of occupational choice

$$\underbrace{\log\left(\frac{\mu_{ijmt}}{\mu_{i0mt}}\right)}_{\Upsilon_{ijmt}} = g\left(\boldsymbol{X}_{ijmt}; \boldsymbol{\Omega}_{ijt}\right)$$

where $\boldsymbol{\Omega}_{ijt} = \tilde{\boldsymbol{\Omega}}_i \bigcup [\sigma_\theta;\ b_{ijt}]$.

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$$\underbrace{\log\left(\frac{\mu_{ijmt}}{\mu_{i0mt}}\right)}_{\Upsilon_{ijmt}} = g\left(\boldsymbol{X}_{ijmt}; \boldsymbol{\Omega}_{ijt}\right) + \epsilon^2_{ijmt}$$

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where $\boldsymbol{\Omega}_{ijt} = \tilde{\boldsymbol{\Omega}}_i \bigcup [\sigma_\theta;\ b_{ijt}]$.

- We get the following moment conditions

$$E\left[\Upsilon_{ijmt} - g\left(\boldsymbol{X}_{ijmt}, \boldsymbol{\Omega}_{ijt}\right) | i, j, t\right] = 0$$
$$E\left[\left(\Upsilon_{ijmt} - g\left(\boldsymbol{X}_{ijmt}, \boldsymbol{\Omega}_{ijt}\right)\right) \boldsymbol{Z}^2_{ijmt}\right] = 0$$

where $\boldsymbol{Z}^2_{ijmt}$ is a vector of instruments.

Estimation of Labor Supply: GMM

- The GMM estimator is

$$\hat{\boldsymbol{\Omega}} = \arg\min_{\boldsymbol{\Omega}} \boldsymbol{M}\left(\boldsymbol{X}, \boldsymbol{Z}; \boldsymbol{\Omega}\right)^T \boldsymbol{M}\left(\boldsymbol{X}, \boldsymbol{Z}; \boldsymbol{\Omega}\right)$$

- In practice, we solve

$$\hat{\boldsymbol{\Omega}} = \arg\min_{\boldsymbol{\Omega}^+} \boldsymbol{M}\left(\boldsymbol{X}, \boldsymbol{Z}; \boldsymbol{\Omega}^+\right)^T \boldsymbol{M}\left(\boldsymbol{X}, \boldsymbol{Z}; \boldsymbol{\Omega}^+\right)$$

$$\text{s.t.} \quad \log\left(\hat{h}_{ijmt}\right) = f\left(\boldsymbol{X}_{ijmt}, \tilde{\boldsymbol{\Omega}}_i\right) \quad \forall i, j, m, t$$

where $\boldsymbol{\Omega}^+ = \boldsymbol{\Omega} \bigcup \{\hat{h}_{ijmt}\}_{\forall i,j,m,t}$

Utility parameters

Estimation of Labor Demand

- The aggregate production function is

$$Y_{mt} = A_t \left[\sum_j \alpha_{jt} \left(\sum_i \beta_{ijt} L_{ijmt} \right)^{\rho} \right]^{\frac{1}{\rho}}$$

- Profit maximization delivers

$$\hat{\beta}_{ijt} = \frac{1}{M} \sum_{m=1}^{M} \frac{w_{ijmt}}{w_{1jmt}}$$

and

$$\log\left(\frac{w_{ijmt}}{w_{i1mt}}\right) = \log\left(\frac{\alpha_{jt}}{\alpha_{1t}}\right) + \log\left(\frac{\hat{\beta}_{ijt}}{\hat{\beta}_{i1t}}\right) + (\rho - 1)\log\left(\frac{\sum_{i'} \hat{\beta}_{i'jt} L_{i'jmt}}{\sum_{i'} \hat{\beta}_{i'1t} L_{i'1mt}}\right)$$

Estimation of Labor Demand

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- Profit maximization delivers

$$\hat{\beta}_{ijt} = \frac{1}{M} \sum_{m=1}^{M} \frac{w_{ijmt}}{w_{1jmt}}$$

and

$$W_{ijmt} = \gamma_{jt} + \psi \hat{B}_{ijt} + \phi \hat{\Lambda}_{jmt} + \epsilon_{ijmt}$$

Estimation of Labor Demand

- We estimate using moments of wage growth (first differences) and instruments

$$\Delta W_{ijmt} = \Delta\gamma_{jt} + \psi\Delta\hat{B}_{ijt} + \phi\Delta\hat{\Lambda}_{jmt} + \epsilon_{ijmt}$$

- Two instruments for $\Delta\hat{\Lambda}_{jmt}$
  - Both instruments predict changes in relative labor inputs

$$\text{IV} = \log\left(\frac{\hat{L}_{jmt}}{\hat{L}_{1mt}}\right) - \log\left(\frac{L_{jmt-1}}{L_{1mt-1}}\right)$$

$\Rightarrow$ Differ in how $\hat{L}_{ijmt}$ is computed

IV1: Labor supply changes predicted by demographic composition
IV2: Labor supply changes predicted by non-pecuniary returns

IV details Estimates

Baseline estimates

Demand for Labor Inputs: Technology

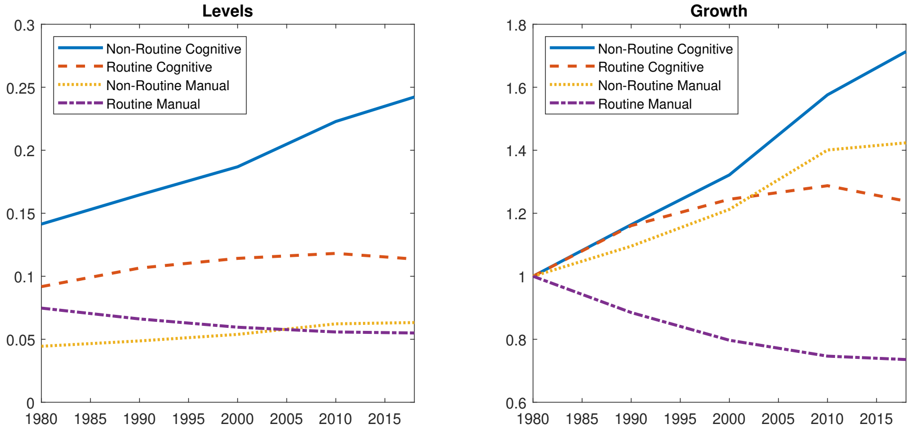
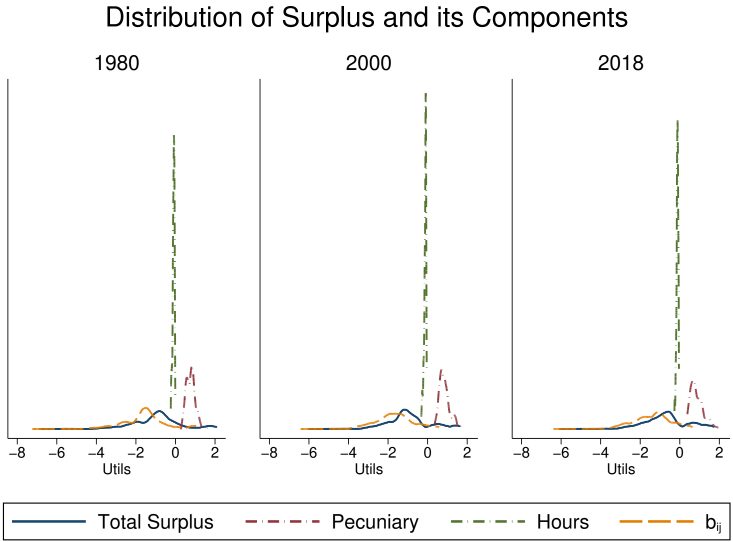


Figure: Weighted average production shares ($\alpha_{jt}\beta_{ijt}$) of major occupation groups. Right: levels. Left: growth relative to 1980.

Labor Supply: Estimates of Surplus Distribution



Technological Transformation with a Changing Workforce

Counterfactuals: Technological Transformation vs Changing Workforce

- Account for structural change in

  1. employment
  2. wages

- Technology? Non-pecuniary match values? Equilibrium effects?

  Three counterfactual scenarios:

  a. hold non-pecuniary returns at their 1980 values $b_{i,j,1980}$

  b. hold technology shares at their 1980 values $\alpha_{j,1980}$ and $\beta_{i,j,1980}$

  c. partial equilibrium: fix wages and employment at 1980 levels

Counterfactuals: Employment Shares

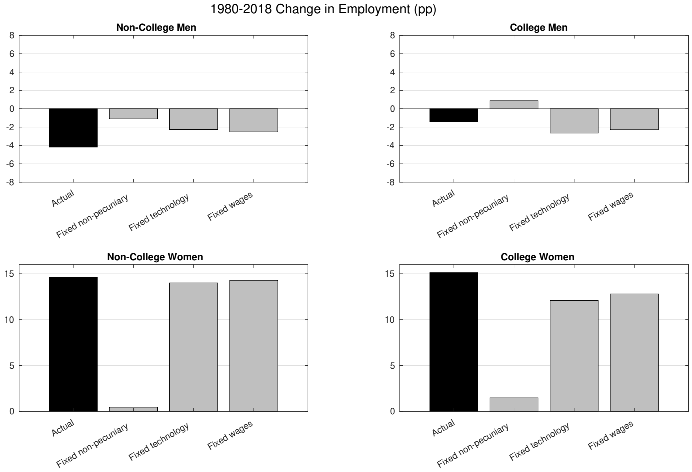


Figure: Changes in employment rates by demographic group. Comparisons of baseline and counterfactual scenarios between 1980 and 2018.

Counterfactuals: Employment Shares II

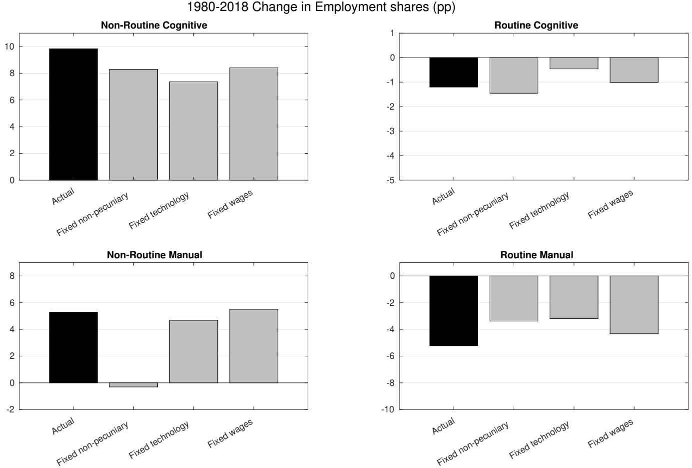


Figure: Changes in employment by occupation type. Comparisons of baseline and counterfactual scenarios between 1980 and 2018.

Counterfactuals: Hourly Wages

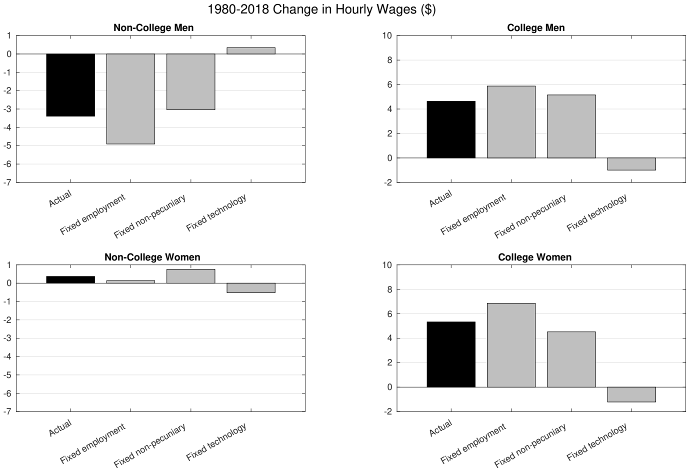


Figure: Changes in average hourly wage by demographic group. Actual versus counterfactual scenarios between 1980 and 2018.

Conclusion

Conclusion

- Structural change mapped into distributions of worker-occupation match values
- Match values broken down in independent components of surplus

  - Emphasize patterns of structural change in the labor market:

    1. Non-pecuniary components more dispersed than pecuniary ones
    2. Dis-utility from hours worked similar across occupations
    3. Differences by gender: non-pecuniary surplus worsened for men, opposite for women
    4. Wage shifts largely dictated by technological change
    5. Changes in employment closely related to non-pecuniary surplus
    6. Compensating differentials and rents increasing over time
    7. Rents becoming more compressed

  - Next steps:
    - What shapes non-pecuniary surplus?
    - Rents and CDs: what accounts for their growth?

Support Slides

Occupations

	Managerial, Professional Specialty and Technical (Non-Routine Cognitive)
1	Executive, Administrative, and Managerial
2	Management Related
3	Professional Specialty
4	Technicians and Related Support

	Sales and Administrative Support (Routine Cognitive)
5	Sales
6	Administrative Support

	Service (Non-Routine Manual)
7	Protective Service
8	Other Service

	Precision Production, Craft, Repair, Operators, Fabricators, and Laborers (Routine Manual)
9	Mechanics and Repairers
10	Construction Trades
11	Precision Production
12	Machine Operators, Assemblers, and Inspectors
13	Transportation and Material Moving

Table: Occupational groupings used for the estimation of the model. Back

Estimated Utility Parameters

	NON-IV	IV		
	(1)	(2)	(3)	(4)
$\hat{\sigma}$	0.3002***	0.2753***	0.2859*	0.2810***
	(0.0536)	(0.0999)	(0.1608)	(0.1039)
$\hat{\sigma}_\theta$	2.97	2.97**	2.97***	2.97***
	(1.95)	(1.51)	(1.12)	(1.11)
Instrumental Variables				
$w_{ijmt-10}$	No	Yes	No	Yes
$w_{ijmt-20}$	No	No	Yes	Yes
y_{imt-10}	No	Yes	No	Yes
y_{imt-20}	No	No	Yes	Yes

Bootstrapped standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table: Estimates of utility parameters. Back

Estimated Technology Parameters

	OLS	IV		
	(1)	(2)	(3)	(4)
$\hat{\phi}$	-0.0834	-0.6041***	-0.5681***	-0.6100***
	(0.0594)	(0.1242)	(0.1388)	(0.1295)
$\hat{\psi}$	0.9771***	0.9771***	0.9771***	0.9771***
	(0.0330)	(0.0330)	(0.0330)	(0.0330)
Observations	2,496	2,496	2,496	2,496
Instrument set		GMMIV1	GMMIV2	GMMIV1-GMMIV2
Test $\hat{\psi} = 1$ (p-val)	0.4880	0.4880	0.4880	0.4880
Overld p-val				0.4152
Implied ρ	0.9166***	0.3959***	0.4319***	0.3900***
	(0.0594)	(0.1242)	(0.1388)	(0.1295)
Implied elast. of sub.	11.9974	1.6554***	1.7604***	1.6394***
	(65.8127)	(0.3833)	(0.4967)	(0.4201)

Bootstrapped standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table: Production function estimates. Back

Instrumental Variables

GMMIV1: Share of types i choosing occupation j held constant. Change in labour supply only comes from demographics:
define $s_{ijm(t-1)}$ the share of i workers choosing occupation j [in $(m, t-1)$]
$\Rightarrow \hat{L}_{ijmt} = s_{ijm(t-1)}\mu_{imt}$

GMMIV2: Use changes in labour supply due to non-pecuniary returns (exogenous)

$$\log\left(\frac{\mu_{ijmt}}{\mu_{i0mt}}\right) = \frac{b_{ijt} + \text{PEC}_{ijmt}}{\sigma_\theta} \implies \Delta\log\left(\frac{\mu_{ijmt}}{\mu_{i0mt}}\right) = \frac{\Delta b_{ijt} + \overbrace{\Delta\text{PEC}_{ijmt}}^{\text{Set}=0}}{\sigma_\theta}$$

$\Rightarrow$ recover predicted shares $\hat{s}_{ijmt}$; use the latter to compute $\hat{L}_{ijmt} = \hat{s}_{ijmt}\mu_{imt}$

Back

Model Fit

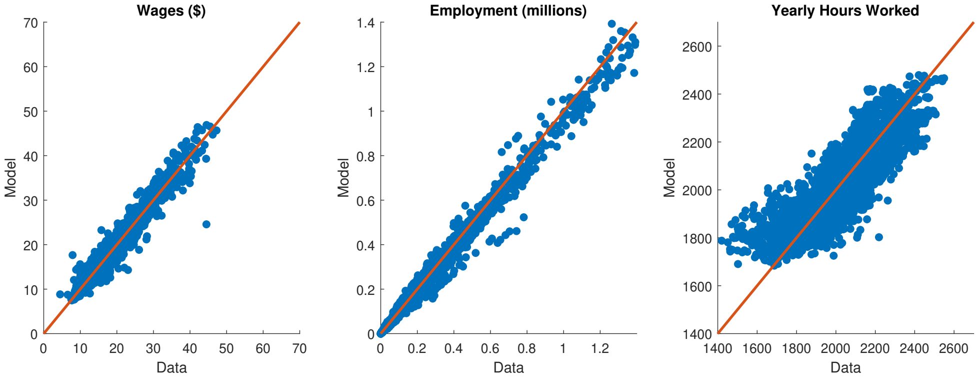


Figure: Goodness of fit. Left: model implied wages vs. data. Center: model implied employment vs. data. Right: model implied hours worked vs. data.

Compensating Differentials and Rents

- Trade-off between pecuniary and nonpecuniary returns generates, at the margin, compensating differentials that can be measured across different worker-job matches.
- Pecuniary and non-pecuniary returns are bundled within a job $\Rightarrow$ rents

1. If j is the occupation of worker ι and j' their second best option, we define **rent** $\tilde{R}^{\iota}_{ijj'mt}$ as the reduction in the worker's wage that makes them indifferent between their choice and the second best occupation:

$$\tilde{U}_i(w_{ijmt} - \tilde{R}^{\iota}_{ijj'mt}, y_{imt}) + b_{ijt} + \theta^{\iota}_j = \tilde{U}_i(w_{ij'mt}, y_{imt}) + b_{ij't} + \theta^{\iota}_{j'}$$

   Compute average rent for each $(ijmt)$ cell.

2. Define **compensating differentials** for marginal workers. Focus on workers indifferent between chosen occupation j and second best choice $j' \Rightarrow \tilde{R}^{\iota}_{ijj'mt} = 0$ in eq. (1). For a marginal worker, one can show that the compensating differential is equal to

$$CD^{\iota}_{ijj'mt} = \tilde{U}_i(w_{ijmt}, y_{imt}) - \tilde{U}_i(w_{ij'mt}, y_{imt}) = CD_{ijj'mt}.$$

   This quantity does not depend on identity of worker, only on observed characteristics.

   (Lamadon, Mogstad and Setzler, 2022)

Compensating differential: averages over time

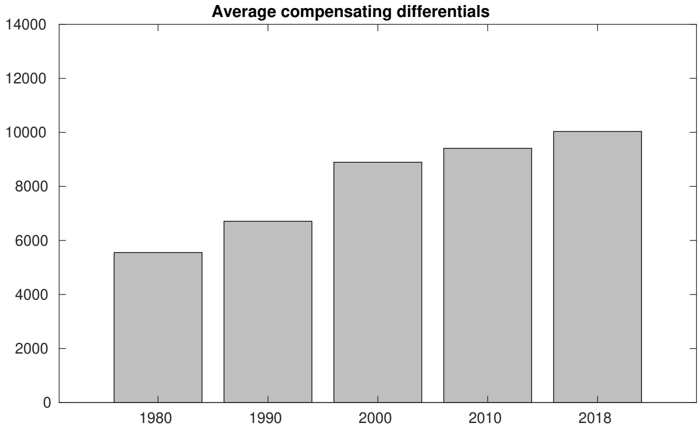
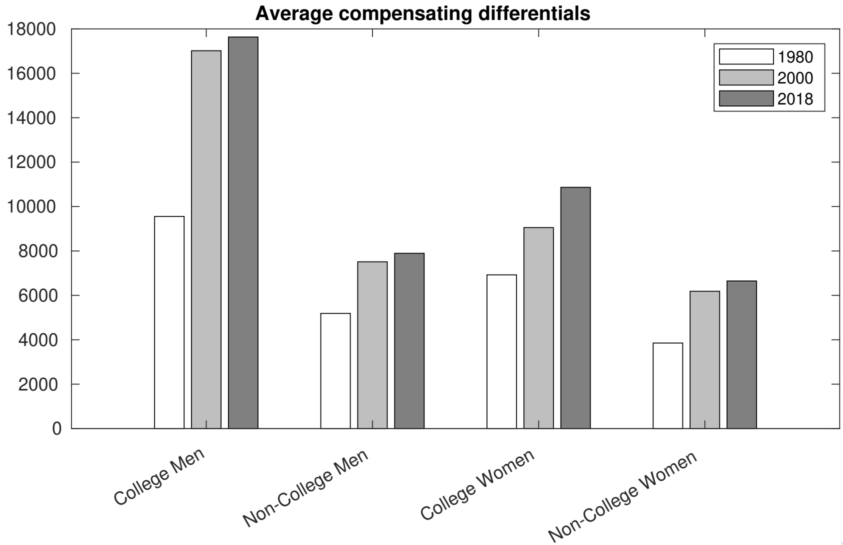
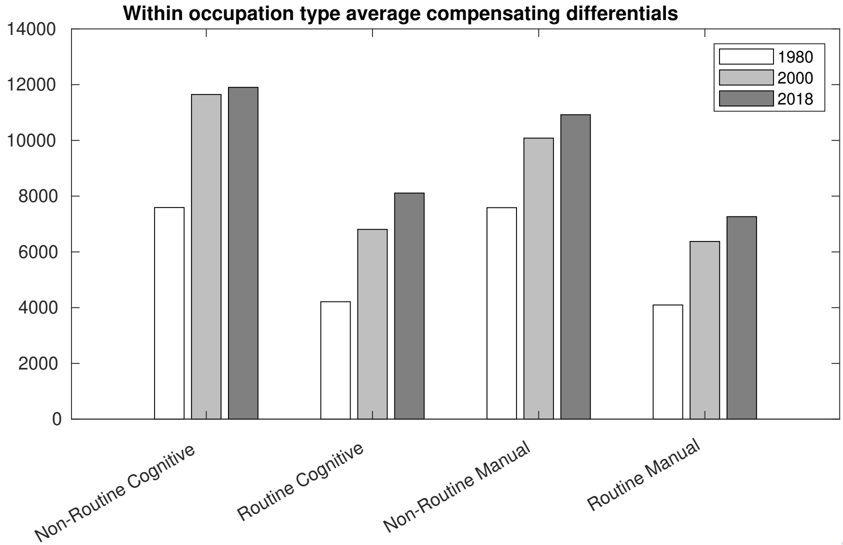


Figure: Mean absolute compensating differentials by year. Year 2000 dollar-equivalents.

Compensating differential: by worker type



Compensating differential: by occupation category



Rents

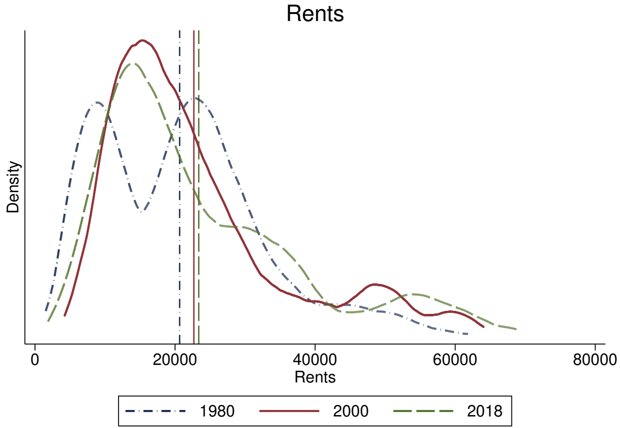


Figure: Distribution of surplus (employment-weighted). Year 2000 dollar-equivalents. Vertical lines correspond to year-specific averages.

Rents

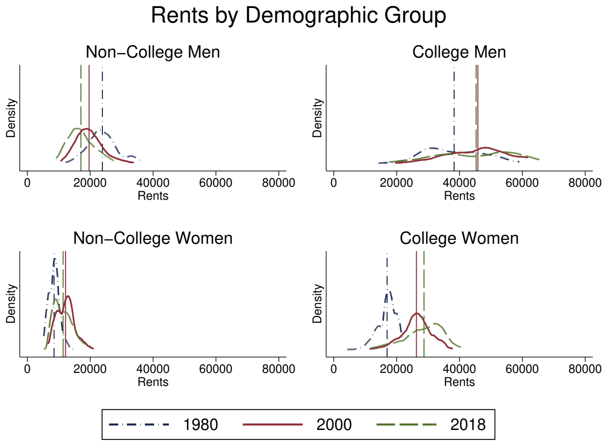


Figure: Distribution of surplus (employment-weighted): disaggregated. All values are in year 2000 dollar-equivalents. The vertical lines correspond to year-specific averages.