Noisy Wage Posting

Francesco Conti, Raymond He, Suryansh Upmanyu

November 1, 2024

University of Texas at Austin

Introduction

Motivation

	Random search	**Directed search**
No wages posted	McCall (1970), Diamond (1982), Mortensen (1982), Pissarides (1985)	N\A
Wages posted	Burdett and Mortensen (1998)	Montgomery (1991), Moen (1997)

Table 1: Taxonomy of labor search models

Shares of wage information across the U.S.

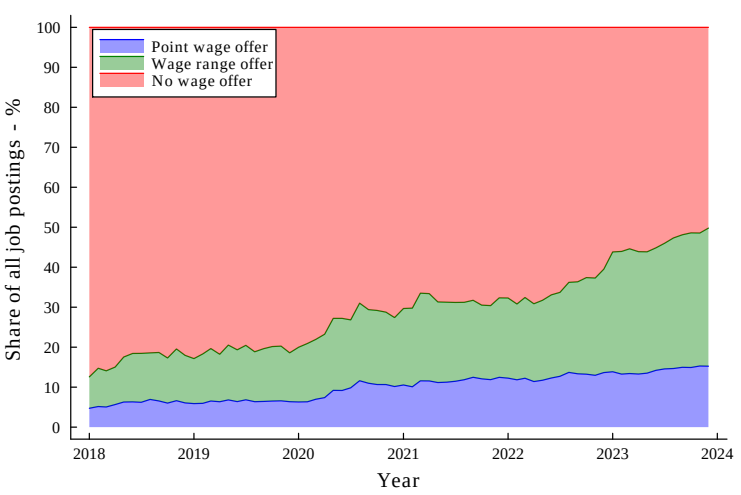

Figure 1: Both wage posting protocols co-exist

Occupation-level wage information shares (2018 - 2020)

Industry-level

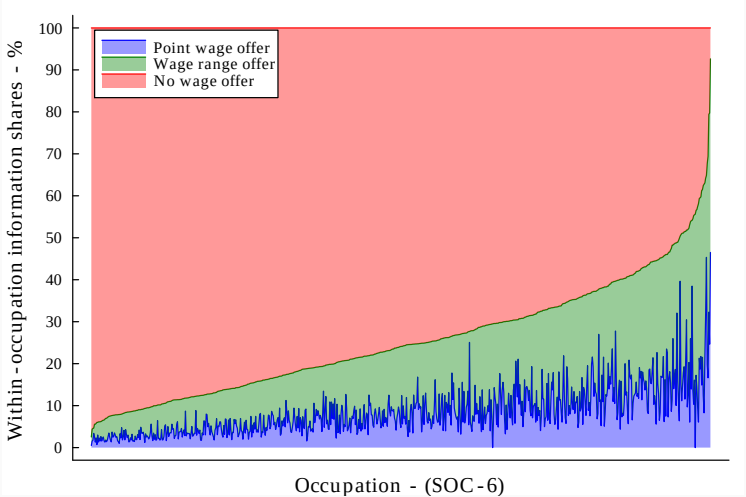

Figure 2: There is significant wage posting heterogeneity at the occupation level

Research Questions

1. Why are some **occupations** transparent about their wages and some ambiguous?
2. What are the equilibrium effects of pay transparency in public job postings?
    - How do wages change?
    - How do firms' profits change?

Literature review

1. **Wage posting behavior:**
   Michelacci and Suarez (2006), Cheremukhin and Restrepo-Echavarria (2020), Flinn and Mullins (2021), Doniger (2023), Rabinovich et al. (2023)
   Contribution: First to explicitly study wage ranges offers rather than just point wage offers.
2. **Pay transparency:**
   Cullen and Pakzad-Hurson (2023)
   Contribution: First to study the welfare effects of *inter*-firm pay transparency, not *intra*-firm.

Stylized facts about wage information

Data

1. BLS Occupational Employment and Wage Statistics
2. Lightcast (formerly EMSI Burning Glass Technologies)

	Number	% of All
All	235,637,477	100.00%
Remove internships	232,658,048	98.74%
Remove missing information	228,515,838	96.98%
Remove postings from Craigslist	219,453,588	93.13%
Remove military & unclassified occupations	212,122,347	90.02%
Remove irrecoverable firm names	204,989,211	86.99%

Table 2: Number of vacancy postings (Jan 2018 - Dec 2023)

Fact 1: Higher skilled jobs are less transparent

Education codes

	$\mathbb{1}$(Has wage information)	
	(1)	(2)
(Intercept)	-0.736***	
	(0.001)	
Minimum education level required	-0.201***	-0.184***
	(0.000)	(0.001)
Minimum years experience required	-0.065***	-0.037***
	(0.000)	(0.000)
SOC 6 & NAICS 5 Fixed Effects		Yes
State & Year Fixed Effects		Yes
N	48,780,216	48,780,216
Pseudo R^2	0.016	0.173

Fact 1: Higher skilled jobs are less likely to have ANY wage information

- $\hat{\beta}_{\text{educ}} = -0.201$
  - -ve relationship between education requirement and Pr(observing wage information)
  - Vacancies requiring **Bachelors** are $\approx$ **8.1 p.p** less likely to have any wage information than vacancies requiring a **high school diploma/GED** (local to 0 years of experience required)
  - **14.39 p.p** difference between **PhDs** and **high school diploma/GED**
- $\hat{\beta}_{\text{exper}} = -0.065$
  - -ve relationship between required experience and Pr(having wage information)
  - Vacancies requiring **5 years** of experience are $\approx$ **6.67 p.p.** less likely to have any wage information than vacancies requiring **0 years** of experience (local to a high school diploma/GED)
  - **12.38 p.p** difference between **10 years** and **0 years**

Fact 1: Higher skilled jobs are less transparent

	$\mathbb{1}$(Is point offer)	
	(1)	(2)
(Intercept)	-0.351***	
	(0.001)	
Minimum education level required	-0.300***	-0.155***
	(0.001)	(0.001)
Minimum years experience required	-0.101***	-0.062***
	(0.000)	(0.000)
SOC 4 & NAICS 5 Fixed Effects		Yes
State & Year Fixed Effects		Yes
N	11,557,071	11,557,070
Pseudo R^2	0.032	0.104

Fact 1: Higher skill jobs are less likely to advertise point-wages

- $\hat{\beta}_{\text{educ}} = -0.300$
  - -ve relationship between education requirement and Pr(wage offer is point)
  - Vacancies with any wage offer requiring **Bachelors** are $\approx$ **13.44 p.p** less likely to have that wage offer be a point than vacancies requiring a **high school diploma/GED** (local to 0 years of experience required)
  - **23.8 p.p** difference between **PhDs** and **high school diploma/GED**
- $\hat{\beta}_{\text{exper}} = -0.101$
  - -ve relationship between required experience and Pr(wage offer is point)
  - Vacancies with any wage offer requiring **5 years** experience are $\approx$ **11.5 p.p** less likely to have that wage offer be a point than vacancies requiring **0 years** experience (local to a high school diploma/GED)
  - $\approx$ **20.9 p.p** difference between **10 years** and **0 years**

Fact 1: Higher skill jobs post wider wage ranges

	Wage range bandwidth			
	(1)	(2)	(3)	(4)
(Intercept)	7.821***		7.757***	
	(0.006)		(0.006)	
Minimum education level required	1.500***	0.437***	2.221***	0.864***
	(0.004)	(0.004)	(0.010)	(0.011)
Minimum years experience required	0.505***	0.296***	0.490***	0.292***
	(0.001)	(0.002)	(0.001)	(0.002)
Minimum education level required^2			-0.300***	-0.175***
			(0.004)	(0.004)
SOC 6 & NAICS 5 Fixed Effects		Yes		Yes
State & Year Fixed Effects		Yes		Yes

Fact 2: Market power and transparency

- Market power measured by the Herfindahl-Hirschman Index (HHI)
  - HHI $< 1,500$: Competitive
  - $1,500 <$ HHI $< 2,500$: Moderately concentrated
  - HHI $> 2,500$: Highly concentrated
- 1 labor market for every occupation **SOC-6** in every **state**
- HH Index for market m at time t is given by

$$HHI_{m,t} = \sum_{j=1}^{J} s_{j,m,t}^2$$

  where

$$s_{j,m,t} = \frac{\text{Number of firm } j\text{'s vacancy posts in market } m \text{ at time } t}{\text{Total number of vacancy posts in market } m \text{ at time } t},$$

  or firm j's market share in market m at time t.
- t in **quarters**

Fact 2: More concentrated labor markets are more transparent

	Has wage information	Is point offer	Mean range width
	(1)	(2)	(3)
HHI/100	0.768***	0.583***	-0.021***
	(0.009)	(0.010)	(0.003)
State Fixed Effects	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes
N	55,640	55,640	55,640
R^2	0.252	0.120	0.051
Within-R^2	0.111	0.063	0.001

Model

Model Preliminaries

- **Agents:**
  - 2 heterogeneous workers: Of types x_l and x_h, $x_l < x_h$, where $x_j \in \mathbb{R}_+$ is the output they produce at a firm.
  - 2 homogeneous firms: risk-neutral
- **Actions:**
  - Firms: Choose w_l and w_h, where $w_l, w_h \in \mathbb{R}_+$
  - Workers: Choose between Firm 1 and Firm 2 (possibly mixed strategy)
- **Payoffs:**
  - If a worker or firm is not matched, they get 0
  - If matched, a worker x_i gets w
  - If matched, a firm gets $x_i - w$

Timeline And Beliefs

- **Timeline:**
  1. Firms simultaneously decide what wages to post $\{w_l^1, w_h^1\}$ and $\{w_l^2, w_h^2\}$
  2. Workers observe the firms' posted wages and decide which firm to apply to
- **Beliefs:**
  - Firms know that there are two types of workers, they know the values of x_l and x_h
  - But they do not know the type of worker that applies to their job

Matching Function

- Both workers prefer to be employed.
- If only 1 worker applies to a firm, he gets matched automatically.
- If both workers apply to the same firm, then one of them is matched with the firm probability $\frac{1}{2}$.
- With a probability $\alpha > \frac{1}{2}$, firms can correctly assess the applicant type x_i, and offer him w_i.
- With probability $1 - \alpha$, the firm makes a mistake and offers applicant x_i wage w_j.

Equilibrium: Worker's Subgame

- Suppose both firms post wage ranges $\{w_l^1, w_h^1\}$ and $\{w_l^2, w_h^2\}$.
- Focus on mixed strategy Nash equilibria in workers' subgame.
- Worker type x_l has strategy $(p_l, 1-p_l)$, type x_h has strategy $(p_h, 1-p_h)$, where p_i is the probability of applying to Firm 1.
- Equilibrium condition for x_i randomizing ($i \in \{l, h\}, j \neq i$):

$$\left[\frac{p_j}{2} + (1-p_j)\right][\alpha w_i^1 + (1-\alpha) w_j^1] = \left[p_j + \frac{1-p_j}{2}\right][\alpha w_i^2 + (1-\alpha) w_j^2]$$

  - Worker type x_i should be indifferent between applying to firm 1 and firm 2.
  - Expected wages depend on whether the other worker applies to the same firm as well.

Equilibrium: Worker's Subgame

- This gives us

$$p_h = \frac{2[\alpha w_l^1 + (1-\alpha)w_h^1] - [\alpha w_l^2 + (1-\alpha)w_h^2]}{[\alpha w_l^1 + (1-\alpha)w_h^1] + [\alpha w_l^2 + (1-\alpha)w_h^2]}$$

$$p_l = \frac{2[\alpha w_h^1 + (1-\alpha)w_l^1] - [\alpha w_h^2 + (1-\alpha)w_l^2]}{[\alpha w_h^1 + (1-\alpha)w_l^1] + [\alpha w_h^2 + (1-\alpha)w_l^2]}$$

- p_i increases if Firm 1 increases either w_l^1 or w_h^1
- p_i decreases if w_l^2 or w_h^2 increases

Equilibrium: Firms' expected profits

Firm 1

$$\mathbb{E}\left[\Pi_1(w_l^1, w_h^1 | w_l^2, w_h^2)\right] = (p_l(1-p_h))[x_l - \alpha w_l^1 - (1-\alpha)w_h^1]$$

$$+ ((1-p_l)p_h)[x_h - \alpha w_h^1 - (1-\alpha)w_l^1]$$

$$+ (p_l p_h)\left[\frac{1}{2}[x_l - \alpha w_l^1 - (1-\alpha)w_h^1] + \frac{1}{2}[x_h - \alpha w_h^1 - (1-\alpha)w_l^1]\right]$$

Equilibrium: Firms' expected profits

Firm 2

$$\mathbb{E}\left[\Pi_2(w_l^2, w_h^2 | w_l^1, w_h^1)\right] = ((1-p_l)p_h)[x_l - \alpha w_l^2 - (1-\alpha)w_h^2]$$

$$+ (p_l(1-p_h))[x_h - \alpha w_h^2 - (1-\alpha)w_l^2]$$

$$+ ((1-p_l)(1-p_h))\left[\frac{1}{2}[x_l - \alpha w_l^2 - (1-\alpha)w_h^2] + \frac{1}{2}[x_h - \alpha w_h^2 - (1-\alpha)w_l^2]\right]$$

Equilibrium: First Order Conditions

Firm 1 profits with respect to w_l^1

$$\left[\left[(1-\frac{p_h}{2})\frac{1-\alpha}{D_l^2}(3(\alpha w_h^2+(1-\alpha)w_l^2))-\frac{p_l}{2}\frac{\alpha}{D_h^2}(3(\alpha w_l^2+(1-\alpha)w_h^2))\right]\times[x_l-\alpha w_l^1-(1-\alpha)w_h^1]-\alpha[p_l(1-\frac{p_h}{2})]\right]$$

$$+\left[\left[(1-\frac{p_l}{2})\frac{\alpha}{D_h^2}(3(\alpha w_l^2+(1-\alpha)w_h^2))-\frac{p_h}{2}\frac{1-\alpha}{D_l^2}(3(\alpha w_h^2+(1-\alpha)w_l^2))\right]\times[x_h-\alpha w_h^1-(1-\alpha)w_l^1]-(1-\alpha)[p_h(1-\frac{p_l}{2})]\right]$$

$$=0$$

Equilibrium: First Order Conditions

Firm 1 profits with respect to w_h^1

$$\left[\left[(1-\frac{p_h}{2})\frac{\alpha}{D_l^2}(3(\alpha w_h^2+(1-\alpha)w_l^2))-\frac{p_l}{2}\frac{(1-\alpha)}{D_h^2}(3(\alpha w_l^2+(1-\alpha)w_h^2))\right]\times[x_l-\alpha w_l^1-(1-\alpha)w_h^1]-(1-\alpha)[p_l(1-\frac{p_h}{2})]\right]$$

$$+\left[\left[(1-\frac{p_l}{2})\frac{(1-\alpha)}{D_h^2}(3(\alpha w_l^2+(1-\alpha)w_h^2))-\frac{p_h}{2}\frac{\alpha}{D_l^2}(3(\alpha w_h^2+(1-\alpha)w_l^2))\right]\times[x_h-\alpha w_h^1-(1-\alpha)w_l^1]-\alpha[p_h(1-\frac{p_l}{2})]\right]$$

$$= 0$$

Equilibrium: First Order Conditions

Firm 2 profits with respect to w_l^2

$$\Bigg[\Big[\frac{(1+p_h)(1-\alpha)}{2D_l^2}(3(\alpha w_h^1+(1-\alpha)w_l^1))-\frac{\alpha(1-p_l)}{2D_h^2}(3(\alpha w_l^1+(1-\alpha)w_h^1))\Big]\times[x_l-\alpha w_l^2-(1-\alpha)w_h^2]$$

$$-\left[\alpha\frac{(1-p_l)(1+p_h)}{2}\right]\Bigg]+$$

$$\Bigg[\Big[\frac{\alpha(1+p_l)}{2D_h^2}(3(\alpha w_l^1+(1-\alpha)w_h^1))-\frac{(1-p_h)(1-\alpha)}{2D_l^2}(3(\alpha w_h^1+(1-\alpha)w_l^1))\Big]\times[x_h-\alpha w_h^2-(1-\alpha)w_l^2]$$

$$-(1-\alpha)\left[\frac{(1-p_h)(1+p_l)}{2}\right]\Bigg]$$

$$=0$$

Equilibrium: First Order Conditions

Firm 2 profits with respect to w_h^2

$$\Bigg[\Big[\frac{\alpha(1+p_h)}{2D_l^2}(3(\alpha w_h^1+(1-\alpha)w_l^1))-\frac{(1-\alpha)(1-p_l)}{2D_h^2}(3(\alpha w_l^1+(1-\alpha)w_h^1))\Big]\times[x_l-\alpha w_l^2-(1-\alpha)w_h^2]$$

$$-(1-\alpha)\left[\frac{(1-p_l)(1+p_h)}{2}\right]\Bigg]+$$

$$\Bigg[\Big[\frac{(1-\alpha)(1+p_l)}{2D_h^2}(3(\alpha w_l^1+(1-\alpha)w_h^1))-\frac{\alpha(1-p_h)}{2D_l^2}(3(\alpha w_h^1+(1-\alpha)w_l^1))\Big]\times[x_h-\alpha w_h^2-(1-\alpha)w_l^2]$$

$$-\alpha\left[\frac{(1-p_h)(1+p_l)}{2}\right]\Bigg]$$

$$=0$$

Conclusion

- We study inter-occupation heterogeneity in wage transparency in the U.S. and empirically find that:
  1. High-skill jobs are less transparent than low-skill jobs
  2. Transparency increases with market power concentration
- Future objectives for the model:
  1. Introduce adverse selection: Worker type x_h does not accept a job because his outside option is more valuable.
  2. Allow firms to opt for bargaining: Firms can resolve the adverse selection problem by opting not to post wages and bargain with a worker instead.
     - Not posting wages comes at a cost: Difficult to attract workers
     - But it allows you to identify worker types perfectly

References

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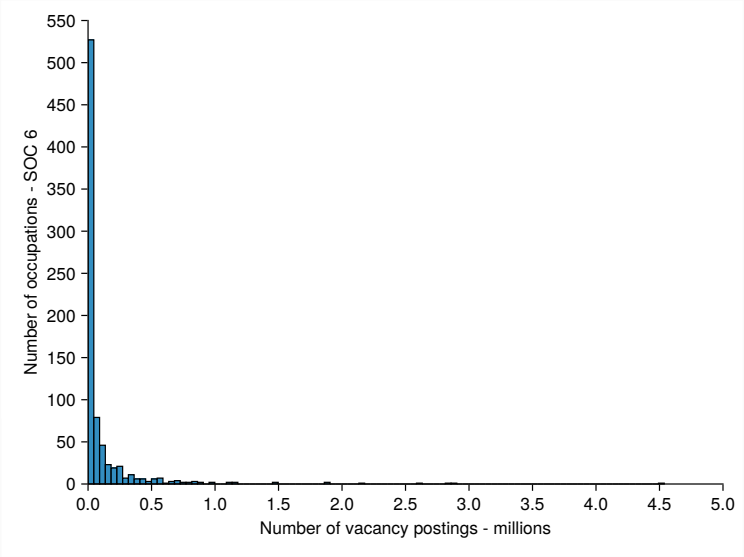
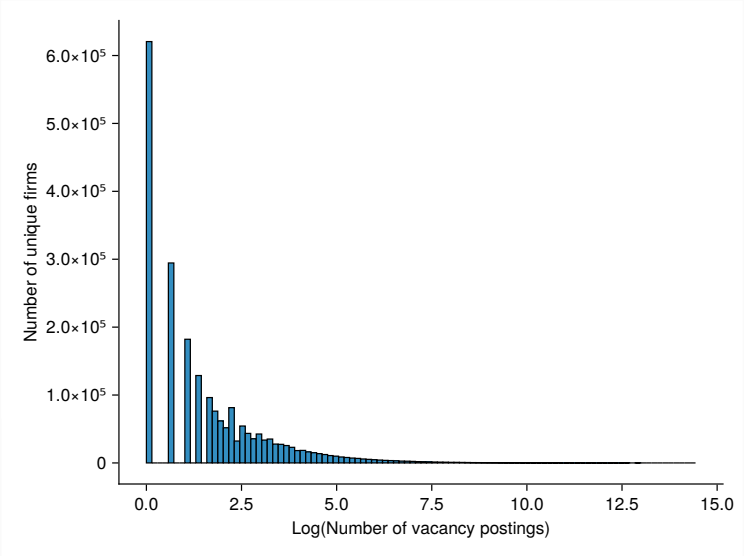
Appendix

Appendix: Occupation size distribution



Appendix: Firm size distribution



Appendix: Data cleaning

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1. Remove all internships
2. Remove all postings with SOC-3 codes 55-900 (military) and 99-900 (unclassified)
3. Remove all postings published **exclusively** to craigslist.org
4. Reclassified postings with imputed wages
5. Reclassified postings whose remuneration structure follows a pay schedule
6. Remove postings with irrecoverable firm names

Appendix: Lightcast firm names

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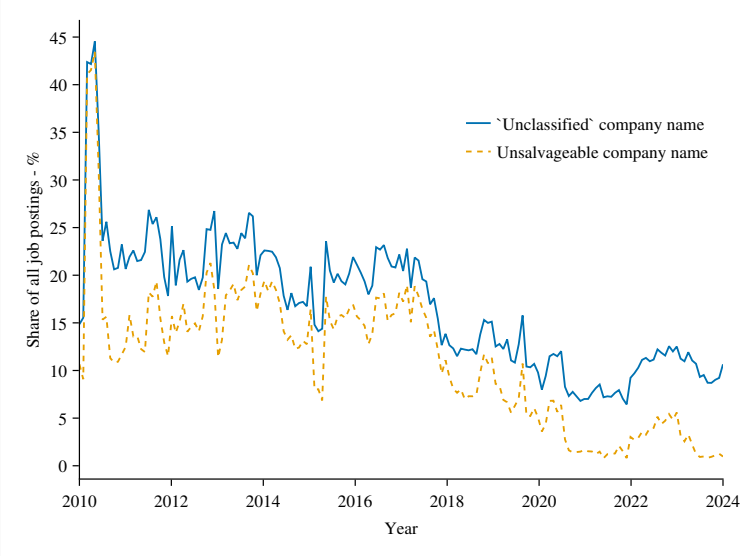

Appendix: Industry-level wage information shares (2018 - 2020)

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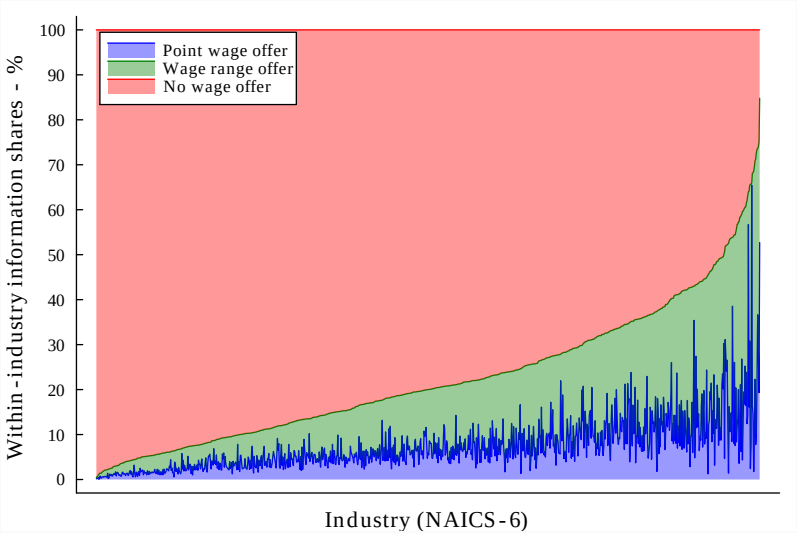

Appendix: Education codes

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- High school or GED: 0
- Associate's degree: 1
- Bachelor's degree: 2
- Master's degree: 3
- PhD or professional degree: 4

High skill jobs have greater within-occupation wage dispersion

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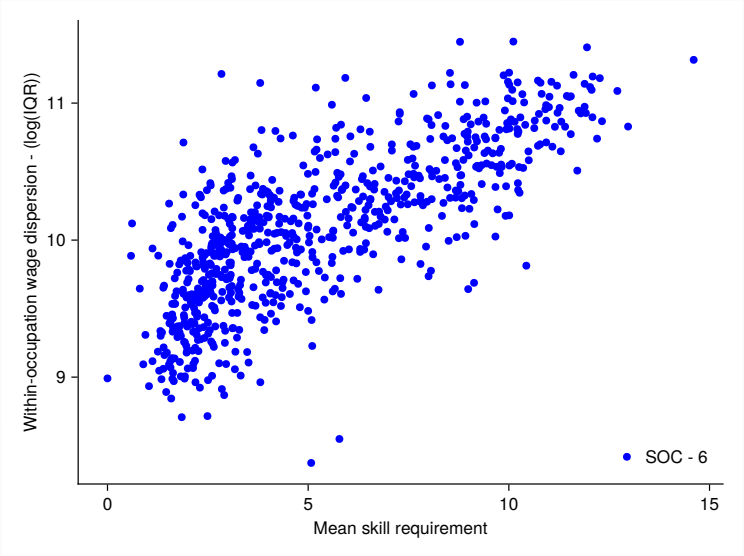

Wage offer vs. realized wages

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