Labor Demand: Minimum Wage and Monopsony

Xuanli Zhu
Keio University

Fall, 2023

Roadmap

1. Introduction
2. The Puzzle of Minimum wage
3. Monopsony Model: basic
4. Monopsony Model: microfoundation

Introduction

- ▷ In perfectly competitive labor market, each firm faces a perfect elastic labor supply
- ▷ If a firm announces a 5 percent wage cut for its employees, how many of them would leave?
- ▷ Perfectly competitive models predict that everyone will leave and the firm will thus stop running (Q: what if a wage rise?)
- ▷ This is why each firm takes market wage as given under perfect competition
- ▷ We know this is not true in most of the real world cases
- ▷ Let's modify our model to cater for and study this part of realistic

Roadmap

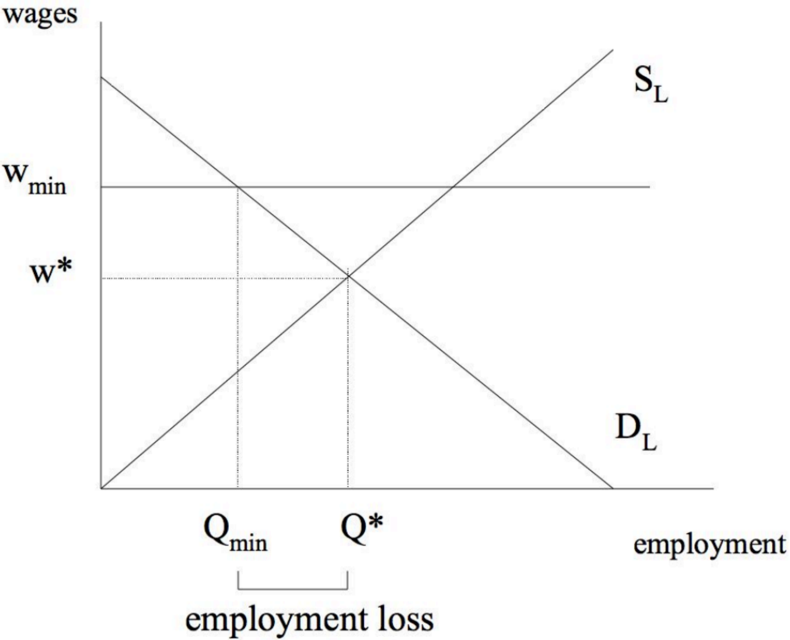
1. Introduction

2. The Puzzle of Minimum wage

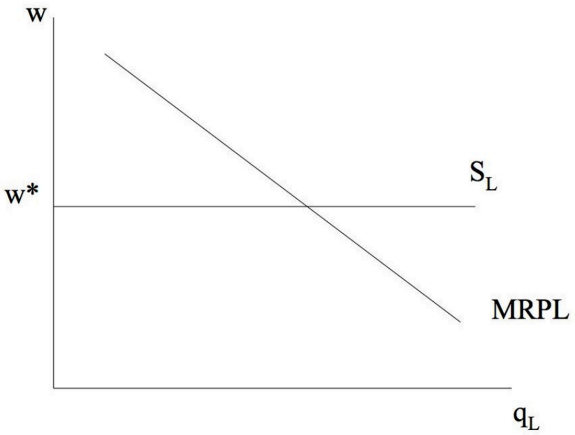
3. Monopsony Model: basic

4. Monopsony Model: microfoundation

Minimum wage in perfectly competitive market



Individual price-taking firm



MRPL = Marginal Revenue Product of Labor $\Longrightarrow$ "What the marginal worker produces."

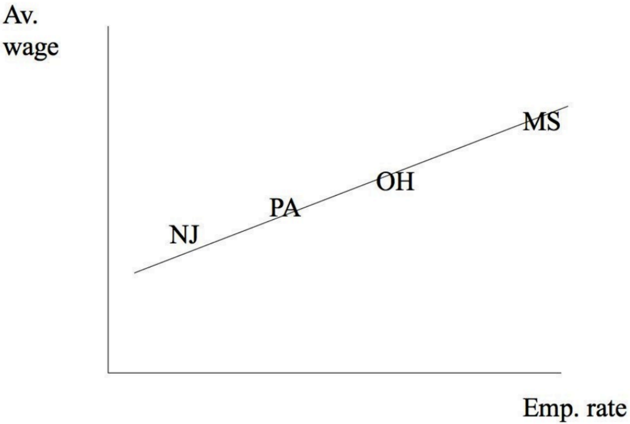
(Q: why downward slopping MRPL?)

Perfectly competitive market and price-taking

- Why firms are price(wage) takers?
  - Labor supply is perfectly elastic (infinitely large)
- When labor supply is perfectly elastic?
  - Number of firms in the market are close to infinity / Each firm is close to be infinitesimal
  - Finite firms do endless (Bertrand) price(wage) competing
  - No searching cost or other frictions
  - No other job characteristics involved in workers' job decisions
- What does price(wage)-taking indicate?
  - Firms face the same horizontal labor supply curve
  - Firms have no power in changing the market prices
  - $MRPL = MC = W$
  - Workers are indifferent working in any firms

What evidence (variations) can be used to test our theory?

Let's suppose you find the following pattern:

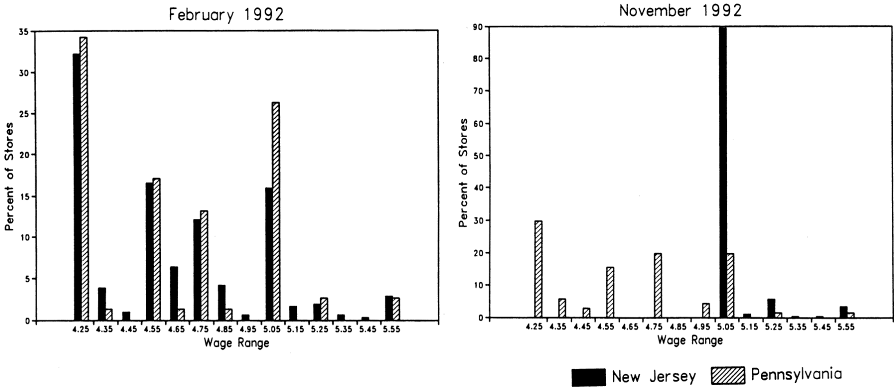


Would this convince you that higher wage levels *caused* higher employment? I hope not!

Card and Krueger (1994)

- How do employers in a low-wage labor market respond to an increase in minimum wage?
- Conventional economic theory: perfectly competitive employers cut employment $\Leftarrow$ Does this really happen?
- CK: why not do an ”experiment”? (intro to casual inference)
- The quasi-experiment (definition): an increase in New Jersey’s minimum wage from \$4.25 to \$5.05 per hour
  - Eastern Pennsylvania (control group) is nearby New Jersey (treatment group) and thus has similar economics conditions
  - High-wage stores (control group) within New Jersey potentially received no impact compared to low-wage stores (treatment group)
  - The rise occurred during a recession while the increase had been legislated two years earlier and decided in last-minute
- CK chose 400+ fast-food restaurants as the experiment targets

CK1994: average starting wage at fast-food stores



CK1994: "difference in differences"

TABLE 3—AVERAGE EMPLOYMENT PER STORE BEFORE AND AFTER THE RISE IN NEW JERSEY MINIMUM WAGE

	Stores by state			Stores in New Jersey[a]			Differences within NJ[b]	
Variable	PA (i)	NJ (ii)	Difference, NJ − PA (iii)	Wage = \$4.25 (iv)	Wage = \$4.26–\$4.99 (v)	Wage ≥ \$5.00 (vi)	Low–high (vii)	Midrange–high (viii)
1. FTE employment before, all available observations	23.33 (1.35)	20.44 (0.51)	−2.89 (1.44)	19.56 (0.77)	20.08 (0.84)	22.25 (1.14)	−2.69 (1.37)	−2.17 (1.41)
2. FTE employment after, all available observations	21.17 (0.94)	21.03 (0.52)	−0.14 (1.07)	20.88 (1.01)	20.96 (0.76)	20.21 (1.03)	0.67 (1.44)	0.75 (1.27)
3. Change in mean FTE employment	−2.16 (1.25)	0.59 (0.54)	2.76 (1.36)	1.32 (0.95)	0.87 (0.84)	−2.04 (1.14)	3.36 (1.48)	2.91 (1.41)
4. Change in mean FTE employment, balanced sample of stores[c]	−2.28 (1.25)	0.47 (0.48)	2.75 (1.34)	1.21 (0.82)	0.71 (0.69)	−2.16 (1.01)	3.36 (1.30)	2.87 (1.22)
5. Change in mean FTE employment, setting FTE at temporarily closed stores to 0[d]	−2.28 (1.25)	0.23 (0.49)	2.51 (1.35)	0.90 (0.87)	0.49 (0.69)	−2.39 (1.02)	3.29 (1.34)	2.88 (1.23)

Notes: Standard errors are shown in parentheses. The sample consists of all stores with available data on employment. FTE (full-time-equivalent) employment counts each part-time worker as half a full-time worker. Employment at six closed stores is set to zero. Employment at four temporarily closed stores is treated as missing.

[a]Stores in New Jersey were classified by whether starting wage in wave 1 equals \$4.25 per hour ($N = 101$), is between \$4.26 and \$4.99 per hour ($N = 140$), or is \$5.00 per hour or higher ($N = 73$).

[b]Difference in employment between low-wage (\$4.25 per hour) and high-wage (≥ \$5.00 per hour) stores; and difference in employment between midrange (\$4.26–\$4.99 per hour) and high-wage stores.

[c]Subset of stores with available employment data in wave 1 and wave 2.

[d]In this row only, wave-2 employment at four temporarily closed stores is set to 0. Employment changes are based on the subset of stores with available employment data in wave 1 and wave 2.

CK1994: other outcomes

Table 6—Effects of Minimum-Wage Increase on Other Outcomes

Outcome measure	Mean change in outcome: NJ (i)	PA (ii)	NJ − PA (iii)	Regression of change in outcome variable on: NJ dummy (iv)	Wage gap[a] (v)	Wage gap[b] (vi)
Store Characteristics:						
1. Fraction full-time workers[c] (percentage)	2.64	−4.65	7.29	7.30	33.64	20.28
	(1.71)	(3.80)	(4.17)	(3.96)	(20.95)	(24.34)
2. Number of hours open per weekday	−0.00	0.11	−0.11	−0.11	−0.24	0.04
	(0.06)	(0.08)	(0.10)	(0.12)	(0.65)	(0.76)
3. Number of cash registers	−0.04	0.13	−0.17	−0.18	−0.31	0.29
	(0.04)	(0.10)	(0.11)	(0.10)	(0.53)	(0.62)
4. Number of cash registers open at 11:00 A.M.	−0.03	−0.20	0.17	0.17	0.15	−0.47
	(0.05)	(0.08)	(0.10)	(0.12)	(0.62)	(0.74)
Employee Meal Programs:						
5. Low-price meal program (percentage)	−4.67	−1.28	−3.39	−2.01	−30.31	−33.15
	(2.65)	(3.86)	(4.68)	(5.63)	(29.80)	(35.04)
6. Free meal program (percentage)	8.41	6.41	2.00	0.49	29.90	36.91
	(2.17)	(3.33)	(3.97)	(4.50)	(23.75)	(27.90)
7. Combination of low-price and free meals (percentage)	−4.04	−5.13	1.09	1.20	−11.87	−19.19
	(1.98)	(3.11)	(3.69)	(4.32)	(22.87)	(26.81)
Wage Profile:						
8. Time to first raise (weeks)	3.77	1.26	2.51	2.21	4.02	−5.10
	(0.89)	(1.97)	(2.16)	(2.03)	(10.81)	(12.74)
9. Usual amount of first raise (cents)	−0.01	−0.02	0.01	0.01	0.03	0.03
	(0.01)	(0.02)	(0.02)	(0.02)	(0.11)	(0.11)
10. Slope of wage profile (percent per week)	−0.10	−0.11	0.01	0.01	−0.09	−0.08
	(0.04)	(0.09)	(0.10)	(0.10)	(0.56)	(0.57)

CK1994: interpretation

- The results are inconsistent with the predictions of a standard competitive model which predicts falling employment
- If fast-food stores face an upward-sloping labor-supply schedule, a rise in the minimum wage can potentially increase employment at affected firms and in the industry as a whole
- This same basic insight emerges from an equilibrium search model in which firms post wages and employees search among posted offers

Roadmap

1. Introduction
2. The Puzzle of Minimum wage
3. Monopsony Model: basic
4. Monopsony Model: microfoundation

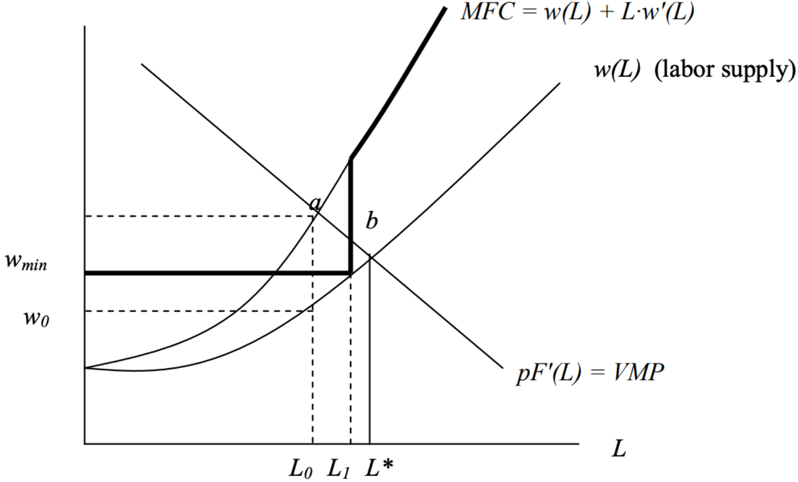
Monopsony: notion

- The term monopsony simply means ”One buyer, many sellers”, similar to monopoly
- There is also oligopsony i.e. ”Several buyers”, similar to oligopoly
- It’s better to take the essence as ”The firm is not a price taker”
- What does it indicate?
    - A firm faces upward slopping labor supply curve
    - A firm’s own demand affects its price (wage)
    - $MRPL = MC > W$
    - Workers can have different wages in different firms

Monopsony: framework

- Firm's profit maximization problem: $\max \pi = p \cdot F(L) - w(L) \cdot L$
  - Normalize product price: $p = 1$
- FOC: $\frac{\partial F(L)}{\partial L} - w(L) - \frac{\partial w(L)}{\partial L} \cdot L = 0$
- Trade-off: $\underbrace{F'(L)}_{MRPL} = \underbrace{w(L) + w'(L)L}_{MC}$
- Under perfectly competitive market & price-taking: $w'(L) = 0$ and $F'(L) = w^*$ where w^* is the market wage
- Under monopsony, firms face an upward slopping labor supply curve, and MC increases in L (Q: why have two terms in MC?)
- $\frac{MRPL}{w} = 1 + \frac{\partial w}{\partial L}\frac{L}{w} \Rightarrow \frac{MRPL}{w} = 1 + \frac{1}{\eta} \Rightarrow w = \frac{MRPL}{1+\frac{1}{\eta}} \Rightarrow w = \mu MRPL$
  - η is the elasticity of labor supply ($\eta \to \infty$ perfect competition)
  - μ is called markdown (similar to markup), indicating the (labor) market power held by the firm (Q: how is η and μ correlated?)

Monopsony and Minimum Wage



(Q: how the η and μ change with the minimum wage?)
(Q: what if the w_{min} is higher than wage at point a?)

Monopsony and Minimum Wage

- Intuition: the marginal costs for workers left to L_1 is pre-paid! With less MC now it is profitable for firms to employ more!
- $w_0 = \mu_0 \times MRPL_0(L_0)$
- $w_{min}(\uparrow) = \mu_1(\uparrow) \times MRPL_1(L_1)(\downarrow)$
- Profit: $\pi = F(L) - wL = F(L) - \mu F'(L)L$
- Recall that with CD production function we have $Y = F(L) = F'(L)L + F'(K)K$ and there is no profit $\pi = 0$;
- With market power, the firm can earn positive profit: $\pi = (1-\mu)Y$, which increase when μ decreases
- $\pi_1 = (1-\mu(\uparrow)) \times Y(\uparrow) < \pi_0$ (by the definition of the profit maximization problem)

Monopsony vs Oligopsony

- The literal sole-employer case is rarely realistic (except say company towns)
- Oligopsony is more often, e.g., considering a Cournot model of employment-setting game with market employment $\mathbf{L} = \sum_i L_i$:
  $\max_{L_i} F_i(L_i) - w\left(L_i + L^*_{-i}\right) L_i \Rightarrow w(L_i) = \left[1 + \frac{1}{\eta(\mathbf{L})}\frac{L_i}{\mathbf{L}}\right]^{-1} F_i'(L_i)$
  - (Q: when will oligopsony market becomes perfectly competitive market or monopsony?)
- Under oligopsony, market structure matters for market power and strategic interactions will play important roles
- Berger et al. (2022) develops a more flexible framework of oligopsony using a CES aggregator of disutility ▸ see appendix
- The definition of the ”oligopsony labor market” is not without disputes; often use [region $\times$ industry or occupation]
  - The implicit idea to separate markets here is to use physical distance and skill-task distance, both of which indicate job moving costs

Roadmap

1. Introduction

2. The Puzzle of Minimum wage

3. Monopsony Model: basic

4. Monopsony Model: microfoundation

Sources of Monopsony Power

- Recall $w_i = \left[1 + \frac{1}{\eta(L_i)}\right]^{-1} \times MRPL_i$, where monopsony is all about $\eta(L_i) \neq \infty$ and $w_i(L_i)$ being upward sloping

- If truly monopsony or oligopsony, the inelastic labor supply can come from household's labor-leisure/homework decision

- But workers can migrate and firms can compete through Bertrand competition (on wage)

- Can we have $w_i(L_i)$ being upward sloping even when each firm is atomistic?

- It turns out that we have two natural sources for such inelastic labor supply:
  - Search friction (for finding jobs)
  - Idiosyncratic preference (on non-wage firm characteristics)

- Often models are first built on these two microfoundations with a continuum of firms and then be relaxed to finite firms

Microfoundation 1: Search Friction

- Workers take time and effort in searching for limited number of jobs, same as firms in searching for workers
- The matching of workers and firms is thus a process with frictions
- Burdett and Mortensen (1998) shows that in a model where homogenous firms post jobs with wages and homogenous workers randomly receive those job offers, there is a unique equilibrium with wage dispersion, where firms have same profits but pay different wages, trading off losing workers to firms paying more with making higher profits on each worker that stays
- Labor supply in BM-type model is upward slopping because it requires a firm posting a higher wage to have more workers attracted and less worker poached, so as to retain a larger employment see a version of the model here
- Perfect competition in this case is reached when job offers from all firms arrive simultaneously and instantaneously to all workers

Microfoundation 2: Idiosyncratic Preference

- Workers often consider more than wages when choosing jobs
- Firms are places to work and consist of a high-dimensional set of (dis)amenities, whose valuations will vary wildly in a given population of workers (similar to cars or breakfast cereal in IO)
  - Location and commute times
  - Fringe benefits
  - Job safety or career potential
  - Relationships with managers and coworkers
  - ...
- Firms may not be able to directly observe this taste heterogeneity and internal constraints on wage discrimination (e.g., internal equity) may force firms to post only one wage per job
- Firms thus know there are some workers who would work for the firm at a wage lower than marginal product, and the amount of workers firms can attract depend on their wages (similar trade-off as the BM model even without search frictions)

Card et al. (2018): worker choices and firm supply

- Each firm $j \in \{1, \ldots, J\}$ posts a pair w_j that all workers costlessly observe (in contrast to search model)
- For worker $i \in \{1, \ldots, \mathcal{L}\}$, the indirect utility of working at firm j:
  $u_{ij} = \beta \ln \left(w_j - b \right) + a_j + \epsilon_{ij}$
  - b is a reference wage (outside option) common to all workers
  - a_j is a firm-specific amenity common to all workers
  - ϵ_{ij} is a i-specific (idiosyncratic) preference for (unobserved amenities of) working at firm j, which are assumed to be i.i.d draws from Type I extreme value (TIEV) distribution
  - (Q: in what case firm-specific labor supply is perfect elastic?)
- Thus workers have logit choice probabilities of working in firm j:
  $$p_j \equiv P\left(\underset{k \in \{1,\ldots,J\}}{\arg\max} \{u_{ik}\} = j \right) = \frac{\exp\left(\beta\left(\ln\left(w_j - b\right) + a_j\right)}{\sum_{k=1}^{J} \exp(\beta \ln(w_k - b) + a_k)}$$
  - Assume that J is very large, then each k term in the denominator has minimal impact, and we have $p_j \approx \lambda \exp\left(\beta \ln\left(w_j - b\right) + a_j\right)$
- Thus, the approximate firm-specific supply functions:
  $\ln L_j\left(w_j\right) \approx \ln\left(p_j \mathcal{L}\right) = \ln\left(\mathcal{L}\lambda\right) + \beta \ln\left(w_j - b\right) + a_j$

Reference

Berger, D., K. Herkenhoff, and S. Mongey (2022). Labor market power. *American Economic Review 112*(4), 1147–1193.

Burdett, K. and D. T. Mortensen (1998). Wage differentials, employer size, and unemployment. *International Economic Review*, 257–273.

Card, D., A. R. Cardoso, J. Heining, and P. Kline (2018). Firms and labor market inequality: Evidence and some theory. *Journal of Labor Economics 36*(S1), S13–S70.

Card, D. and A. B. Krueger (1994). Minimum wages and employment: A case study of the fast-food industry in new jersey and pennsylvania. *The American Economic Review 84*(4), 772–793.

Manning, A. (2003). Monopsony in motion: imperfect competition in labor markets.

Appendix

Oligopsony as CES labor supply system: Setting

- Here I show a simplified version of the model in Berger et al. (2022)
- Firms indexed by $i \in \{1, 2, \ldots, m_j\}$ compete in a local labor market j and a perfectly competitive product market with productivities $z_i \in (0, \infty)$ and production function $Y_i = z_i F(L_i)$
- Representative household with problem:

$$\max_{C_i, L_i} U_j \left(\mathbf{C} - \frac{\mathbf{L}^{\frac{\phi+1}{\phi}}}{\frac{\phi+1}{\phi}} \right) \text{ s.t. } \mathbf{C} = \sum_{i \in j} W_i L_i + \Pi_j, \ \mathbf{L} = \left(\sum_{i \in j} L_i^{\frac{\eta+1}{\eta}} \right)^{\frac{\eta}{\eta+1}}$$

- FOC: $\mathbf{L}^{\frac{1}{\phi}} \frac{\partial \mathbf{L}}{\partial L_i} = W_i \Rightarrow \mathbf{L}^{\frac{1}{\phi}+1} \left(\frac{L_i}{\mathbf{L}} \right)^{\frac{\eta+1}{\eta}} = W_i L_i$
- Thus a firm i faces its wage function: $W_i = \mathbf{L}^{\frac{1}{\phi} - \frac{1}{\eta}} L_i^{\frac{1}{\eta}}$

Oligopsony as CES labor supply system: Solution

- Firm profit maximization problem: $\Pi_i = \max_{L_i} Y_i - W_i L_i$ s.t.

$$W_i\left(L_i, L_{-i}^*\right) = \mathbf{L}^{\frac{1}{\phi}-\frac{1}{\eta}} L_i^{\frac{1}{\eta}}, \mathbf{L}\left(L_i, L_{-i}^*\right) = \left[L_i^{\frac{\eta+1}{\eta}} + \sum_{k\neq i} L_k^{*\frac{\eta+1}{\eta}}\right]^{\frac{\eta}{\eta+1}}$$

- FOC: $\dfrac{\partial Y_i}{\partial L_i} = W_i + \left.\dfrac{\partial W_i}{\partial L_i}\right|_{L_{-i}^*} L_i \Leftrightarrow mpl_i = mc_i$

- $\Rightarrow mpl_i = W_i\left[1 + \frac{\partial W_i}{\partial L_i}\frac{L_i}{W_i}\right] = W_i\left[1 + \frac{1}{\eta} + \left(\frac{1}{\phi} - \frac{1}{\eta}\right)\left(\frac{L_i}{\mathbf{L}}\right)^{\frac{\eta+1}{\eta}}\right]$

- Define labor cost share: $s_i = \frac{W_i L_i}{\sum_i W_i L_i} = \frac{\mathbf{L}^{\frac{1}{\phi}-\frac{1}{\eta}} L_i^{\frac{1}{\eta}+1}}{\sum_i \mathbf{L}^{\frac{1}{\phi}-\frac{1}{\eta}} L_i^{\frac{1}{\eta}+1}} = \left(\frac{L_i}{\mathbf{L}}\right)^{\frac{\eta+1}{\eta}}$

$$mpl_i = W_i/\mu_i, \text{where } \mu_i = \frac{\varepsilon_i}{\varepsilon_i + 1}, \text{ and}$$

- $\Rightarrow$

$$\varepsilon_i := \left[\left.\frac{\partial \ln W_i}{\partial \ln L_i}\right|_{L_{-i}}\right]^{-1} = \left[(1 - s_i)\frac{1}{\eta} + s_i\frac{1}{\phi}\right]^{-1}$$

Oligopsony as CES labor supply system: Simulation

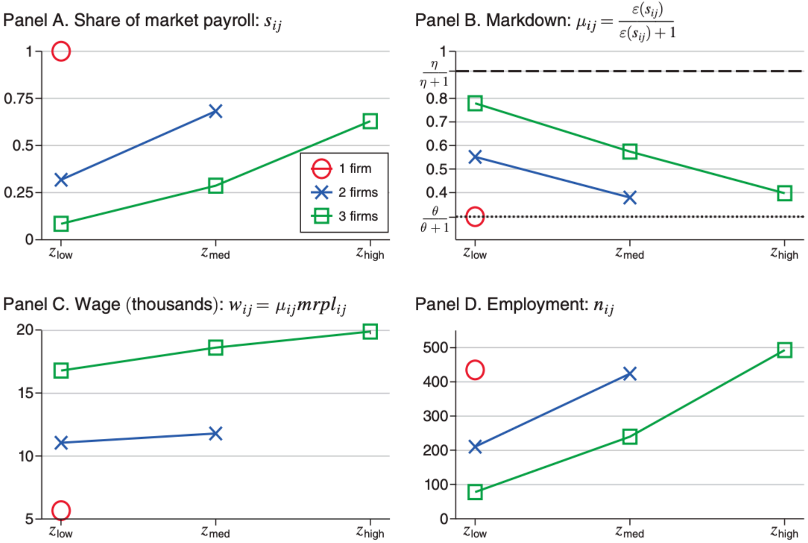


FIGURE 3. OLIGOPSONISTIC MARKET EQUILIBRIUM IN THREE LABOR MARKETS

Notes: Figure constructed from model under estimated parameters (Table 3). Low, medium, and high productivities of the firms correspond to the tenth, fiftieth, and ninetieth percentiles of the productivity distribution.

Microfounding the CES labor supply system with a static discrete choice framework

- A unit measure of ex-ante identical individuals indexed by $l \in [0, 1]$
- A large but finite set of J sectors in the economy, with finitely many firms $i \in \{1, \ldots, M_j\}$ in each sector
- Worker l' s disutility of working h_{lij} hours at firm ij are: $v_{lij} = e^{-\xi_{lij}} h_{lij}$, where the random utility term $\tilde{\xi}_{lij}$ is distributed iid from a multi-variate Gumbel distribution: $F(\xi_{i1}, \ldots, \xi_{NJ}) = \exp\left[-\sum_{ij} e^{-(1+\eta)\xi_{ij}}\right]$
- Each individual must earn $y_l \sim F(y)$, where earnings $y_l = w_{ij} h_{lij}$
- After drawing their vector $\{\xi_{lij}\}$, each worker solves $\min_{ij} \{\log h_{lij} - \xi_{lij}\} \equiv \max_{ij} \{\log w_{ij} - \log y_l + \xi_{lij}\}$
- This problem delivers the following probability that worker chooses to work at firm ij: $\text{Prob}_l(w_{ij}, w_{-ij}) = \frac{w_{ij}^{1+\eta}}{\sum_{ij} w_{ij}^{1+\eta}}$

Static discrete choice framework: firm labor supply

- Integrate to find the total labor supply to firm *ij*:

$$n_{ij} = \int_0^1 \text{Prob}_l\left(w_{ij}, w_{-ij}\right) h_{lij} dF\left(y_l\right) \quad , \quad h_{lij} = y_l / w_{ij}$$

$$n_{ij} = \frac{w_{ij}^{\eta}}{\sum_{i\in j} w_{ij}^{1+\eta}} \underbrace{\int_0^1 y_l dF\left(y_l\right)}_{:=Y}$$

- Aggregating this expression: $\sum_{i\in j} w_{ij} n_{ij} = Y$

- Now define the following indexes:

$$\boldsymbol{W} := \left[\sum_{i\in j} w_{ij}^{1+\eta}\right]^{\frac{1}{1+\eta}} , \quad \boldsymbol{N} := \left[\sum_{i\in j} n_{ij}^{\frac{\eta+1}{\eta}}\right]^{\frac{\eta}{\eta+1}}$$, and note $\boldsymbol{W}\boldsymbol{N} = Y$

- Substituting back yields the CES supply curve: $n_{ij} = \left(\frac{w_{ij}}{\boldsymbol{W}}\right)^{\eta} N$

Static discrete choice framework: nested CES

- This discrete choice framework thus derives the supply system equivalent to the case where a representative household solves the utility maximization problem: $\max_{\{n_{ij}\}} \sum_{i\in j} w_{ij} n_{ij} - \left[\sum_{i\in j} n_{ij}^{\frac{\eta+1}{\eta}}\right]^{\frac{\eta}{\eta+1}}$
- Berger et al. (2022) shows that we can also microfound a nested CES supply system (with btw-market competition)
  $\max U(\mathbf{C}_t, \mathbf{N}_t), \mathbf{N}_t := \left[\int_0^1 \mathbf{n}_{jt}^{\frac{\theta+1}{\theta}} dj\right]^{\frac{\theta}{\theta+1}}, \mathbf{n}_{jt} := \left[\sum_{i\in j} n_{ijt}\right]^{\frac{\eta}{\eta+1}}$ with a nested logit, $F(\xi_{i1}, \ldots, \xi_{NJ}) = \exp\left[-\sum_{j=1}^{J}\left(\sum_{i=1}^{M_j} e^{-(1+\eta)\tilde{\xi}_{ij}}\right)^{\frac{1+\theta}{1+\eta}}\right]$
- Elasticity of substitution η or θ has a natural interpretation here
  - A higher value of η means higher correlation of draws within a market, thus people has little difference in preference for different firms and the wage posting is closer to the competitive outcome

Early recognitions on the general presence of labor market power even in the absence of ”concentration”

- *The supply of labour to an individual firm might be limited ... there might be a certain number of workers in the neighborhood and to attract those from further afield it may be necessary to pay a wage equal to what they can earn near home plus their fares to and fro, or there may be workers attached to the firm by preference or custom and to attract others it may be necessary to pay a higher wage. Or ignorance may prevent workers from moving from one firm to another in response to differences in the wages offered by the different firms.* (Robinson [1933] 1969, p. 296)

- *The assumption that workers are fully informed and completely responsive to wage differences may be altered in three main ways. It may be assumed that workers are ignorant of the wages paid by other employers, or that they are perfectly informed concerning wages but are deterred from changing jobs by considerations of security, or that they are perfectly informed concerning wages but differ in their evaluation of the non-base-rate components of the wage.* (Reynolds 1946, p. 393)

BM Model: setting and behavior

- Here we show a simplified BM model in Manning (2003)
- M_w homogenous workers and M_f homogenous firms
- Firms post wages with CDF $F(w)$ which is an equilibrium outcome
- Both employed & non-employed workers randomly receive job offers from $F(w)$ at a rate λ
- Employed workers return to non-employment at an exogenous job destruction rate δ
- An employed worker will move whenever a wage offer above the current wage is received
- A non-employed worker will accept a job whenever the wage offer received is above some reservation wage, $r = b$, where b is the value of leisure (not the case if λ differs for employed and not)

BM Model: steady state and labor supply

- Denote u as the unemployment rate, in the steady state we have: $\lambda u M_w = \delta(1-u)M_w \Rightarrow u = \frac{\delta}{\delta+\lambda}$
- Denote by $G(w;F)$ the fraction of employed workers receiving a wage $\leq w$, in the steady state we have:
$$\underbrace{[\delta+\lambda(1-F(w))]}_{\text{outflow rate}} G(w;F)(1-u)M_w = \underbrace{\lambda F(w)}_{\text{inflow rate}} uM_w$$
- $\Rightarrow G(w;F) = \frac{\delta F(w)}{\delta+\lambda[1-F(w)]}$
- Denote by $N(w;F)$ the firm labor supply, we have
$$\underbrace{\{\delta+\lambda[1-F(w)]\}}_{\text{separation rate}} N(w;F) = \underbrace{\frac{\lambda}{M_f}\left[uM_w + G(w;F)(1-u)M_w\right]}_{\text{recruitment}}$$
$$\Rightarrow N(w;F) = \frac{M_w}{M_f}\frac{\delta\lambda}{[\delta+\lambda(1-F(w))]^2}$$

BM Model: equilibrium profit and wage distribution

- All employers have CRS with the productivity of each worker being p: $\pi = (p - w)N(w; F) = (p - w)\frac{M_w \delta\lambda}{M_f[\delta+\lambda(1-F(w))]^2}$
- In the equilibrium, all firms have the same profits; For a firm pays the lowest wage, b, its profit is $\pi^* = (p - b)\frac{M_w \delta\lambda}{M_f[\delta+\lambda]^2}$
- Thus offered wages lie in the interval $b \leq w \leq p - \left(\frac{\delta}{\delta+\lambda}\right)^2 (p - b)$ and within this interval, the equilibrium wage offer distribution is $F(w) = \frac{\delta+\lambda}{\lambda}\left[1 - \sqrt{\frac{p-w}{p-b}}\right]$
- $\Rightarrow G(w; F) = \frac{\delta F(w)}{\delta+\lambda[1-F(w)]} = \frac{\delta}{\lambda}\left[\sqrt{\frac{p-b}{p-w}} - 1\right]$
- Finally, the expected wage:

$$E(w) = \frac{M_f \int wN(w; F)dF(w)}{M_f \int N(w; F)dF(w)} = p - \frac{M_f \int (p - w)N(w; F)dF(w)}{M_w(1 - u)}$$
$$= p - \frac{M_f \int \pi^* dF(w)}{M_w(1 - u)} = p - \frac{M_f \pi^*}{M_w(1 - u)} = p - \frac{\delta(p - b)}{\delta + \lambda}$$

BM Model: implication

- Expected wage: $E(w) = \frac{\lambda}{\delta+\lambda}p + \frac{\delta}{\delta+\lambda}b$
  - I.e. a weighted average of marginal product and reservation wage
  - The weights depend on λ/δ, which measures the rate at which searching workers encounter offers relative to they lose jobs

- As $(\lambda/\delta) \to \infty$ (job offers arrive infinitely fast), the distribution of wages across workers collapses to the perfectly competitive equilibrium in which all workers get paid their marginal product, p
  - In this market, firms cannot pay a lower wage than p as the threat of workers leaving by poaching is a very real one

- As $(\lambda/\delta) \to 0$, the distribution of wages across workers again collapses, with all workers paid their reservation wage, b
  - In this market, firm will not pay a higher wage than w as there is no effective competing on workers at all

- Thus search frictions and any artifices (e.g. no-poaching agreements) that make it difficult to poach workers who are already employed naturally reduce (λ/δ) and push towards monopsony

Card et al. (2018): firm optimization

- Assume firms have CRS production functions: $Y_j = T_j f\left(L_j\right)$, and product market is perfectly competitive
- Firm's problem: $\max_{w_j} T_j f\left(L_j\left(w_j\right)\right) - w_j L_j\left(w_j\right)$
- FOC: $T_j f_L \frac{\partial L_j}{\partial w_j} = L_j + w_j \frac{\partial L_j}{\partial w_j} \Rightarrow \underbrace{T_j f_L}_{mp_j} = \underbrace{w_j(1 + 1/e_j)}_{mc_j}$, where

  $e_j \equiv \left[\frac{\partial L_j}{\partial w_j}\frac{w_j}{L_j}\right]$ is the firm-specific elasticity of supply
- Recall $\ln L_j\left(w_j\right) = \ln\left(\mathcal{L}\lambda\right) + \beta \ln\left(w_j - b\right) + a_j \Rightarrow e_j = \frac{\beta w_j}{w_j - b}$
- $\Rightarrow w_j = \frac{1}{1+\beta} b + \frac{\beta}{1+\beta} T_j f_L$
  - Similar to the BM search model, the wage here is again a weighted average of the reference wage and marginal revenue product
  - However, workers are better "paid off" here: most workers (except last worker hired who is indifferent) are infra-marginal and strictly prefer their job to outside alternatives