Outside Options in the Labor Market

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Fall 2022

Motivation

In standard models of the labor market workers' wages depend on (typically unobserved) outside options

- Perfect competition: equally attractive option always exists $\implies w = MP$
- Reality: next best option could vary in location, skill requirements, etc.

Outside job opportunities could vary across workers

- Could generate lower wages even for equally productive workers
- Ex: Women may have fewer options on average if they are less willing or able to commute

Challenge: Outside options are typically unobserved

This Paper

Develop a method to estimate workers' outside employment opportunities

- Adapt standard marriage market models for use in the labor market (Becker 1973, Shapley-Shubik 1971)
- From this model, derive a sufficient statistic for outside options: Outside Options Index (OOI)
- "Concentration" index: learn about outside options from equilibrium outcomes of similar workers

Apply this model to German linked employer-employee data

1. Estimate empirical link between OOI and wage using a standard shift-share instrument
   - 10% more options $\implies$ 1.7% higher wages
2. 20% of gender gap is driven by differences in OOI (all coming from distance)

Related Literature

1. **Matching Models With Transfers**
   - Shapely & Shubik (1971), Becker (1973), Ekeland, Heckman & Nesheim (2004), Choo & Siow (2006), Dupuy & Galichon (2014)
2. **Labor Market Imperfections and Wage Gaps**
   - Robinson (1933), Black (1995), Manning (2003) , Ransom & Oaxaca (2010), Hirsch et al. (2010), Beaudry, Green & Sand (2012), Hsieh et al. (2013), Bidner & Sand (2016), Card, Cardoso & Kline (2016), Card, Cardoso, Heining & Kline (2018), Lamadon, Mogstad & Setzler (2019)
3. **Definition of a Labor Market**
   - Manning & Petrongolo (2017), Nimczik (2018)
4. **Labor Market Concentration**
   - Handwerker & Spletzer (2015), Marinescu et al. (2018), Benmelech et al. (2018), Berger et al. (2019), Jarosch, Nimczik & Sorkin (2019), Berger, Herkenhoff & Mongey (2020), Schubert, Stansbury & Taska (2020)

Theory

Empirical Setting and Data

Heterogeneity in Outside Options

Outside Options and Wage Inequality

Matching Model with Two-Sided Heterogeneity

Continuum of **workers** of mass $\mathscr{I} = 1$ and **one-job firms** of mass $\mathscr{J} = 1$

If matched to **firm** j, **worker** i produces

$$\underbrace{\tau_{ij}}_{\text{total value}} = \underbrace{y_{ij}}_{\text{output}} + \underbrace{a_{ij}}_{\text{amenities}}$$

Wages are used to transfer utility

$$\begin{aligned}\underbrace{\tau_{ij}}_{\text{total value}} &= \left(\underbrace{a_{ij}}_{\text{amenities}} + \underbrace{w_{ij}}_{\text{wages}}\right) + \left(\underbrace{y_{ij}}_{\text{output}} - \underbrace{w_{ij}}_{\text{wages}}\right) \\ &= \underbrace{\omega_{ij}}_{\text{compensation}} + \underbrace{\pi_{ij}}_{\text{profit}}\end{aligned}$$

Equilibrium

Solve as a cooperative game (Shapley Shubik 1971)

- Static framework
- Perfect information

Equilibrium consists of an allocation M and transfer w_{ij} for each $(i, j) \in M$ which satisfies Details

$$\forall i' \in \mathcal{I}, j' \in \mathcal{J} \quad : \quad \omega_{i', m(i')} + \pi_{m^{-1}(j'), j'} \geq \tau_{i'j'} \tag{1}$$

- Workers must earn more than they could elsewhere
- Firms must earn more than they could by hiring a different worker
- Compensation depends on distributions of productivity (y) and preferences (a)

Functional Form Assumptions

1. Workers and jobs can be characterized by characteristics $\mathcal{X} \subseteq \mathbb{R}^{d_x}$ and $\mathcal{Z} \subseteq \mathbb{R}^{d_z}$
   - Notation: **worker** i has characteristics X_i (density: $d(X_i)$) & **firm** j has characteristics Z_j (density: $g(Z_j)$)

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2. Allow for idiosyncratic preferences (Choo & Siow, 2006, Dupuy & Galichon, 2014)

$$\tau_{ij} = \tau(x_i, z_j) + \epsilon_{i,z_j} + \varepsilon_{j,x_i}$$

2.1 $\varepsilon \sim$ come from continuous logit models with scale α_x, α_z Details
   - Allows us to account for continuous observed characteristics (e.g. distance)
   - Similar to standard MNL logit – but $\omega \not\to \infty$ as (Cosslett 1988; Dagsvik 1994)

2.2 $\varepsilon_{i,z_j} \perp \varepsilon_{j,x_i}$

- Rules out interactions between worker/firm preferences

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   - Rules out interactions between worker/firm preferences

IIA: Unobserved taste for jobs in an neighborhood of z uncorrelated with unobserved taste for jobs in a neighborhood of $z' \neq z$

Outside Options and Compensation

In equilibrium [Proofs in Appendix A.5]:

1. Workers (employers) get "their" ε_{i,z_j} (ε_{j,x_i})

$$\omega_{ij} = \omega(x_i, z_j) + \epsilon_{i,z_j}, \quad \pi_{ij} = \pi(x_i, z_j) + \varepsilon_{j,x_i}$$

2. The systematic portion of workers' compensation satisfies

$$\omega(x,z) = \frac{\alpha_x}{\alpha_x + \alpha_z}\left(\underbrace{E\left[\omega|x_i\right]}_{\text{Expected Compensation}}\right) + \frac{\alpha_z}{\alpha_x + \alpha_z}\left(\underbrace{\tau\left(x,z\right) - E\left[\pi|z\right]}_{\text{firm "rents"}}\right)$$

Note: $\frac{\alpha_z}{\alpha_x+\alpha_z}$ is larger when workers' idiosyncratic preferences are more variable than firms'

Outside Options and Compensation

We can also decompose worker i's expected equilibrium compensation:

$$\underbrace{E\left[\omega_{ij}^{*}|x_i\right]}_{\text{Expected compensation}} = \underbrace{E\left[\tau\left(x_i, z_j^{*}\right)|x_i\right]}_{\text{Mean Production}} - \underbrace{E[\pi_{i,j^*}|x_i]}_{\text{Employer Rents}} + \underbrace{\left(\frac{\alpha_x + \alpha_z}{\alpha_z}\right) E\left[\varepsilon_{i,z^*}|x_i\right]}_{(\alpha_x+\alpha_z)\cdot OOI}$$

- Assuming firm profits stay constant, the OOI is a sufficient statistic for the effect of outside options on wages [Appendix A.3]

Definition of Outside Options Index (OOI)

OOI is $E\left[\varepsilon_{i,z^*}|x_i\right]$ de-scaled

$$OOI_i = \alpha_z^{-1} E\left[\varepsilon_{i,z^*}|x_i\right] = -\int f_{Z|X}\left(z_j|x_i\right) \log \frac{f_{Z|X}\left(z_j|x_i\right)}{g\left(z_j\right)}$$

- Expected **equilibrium** value of ϵ_{i,z_j} for workers with characteristics x_i
- **Concentration** index that depends on both discrete and continuous characteristics
  - Varies across workers due to differences in both preferences and skill (captured in x_i)
  - May vary across workers with identical x_i due to labor market conditions (available z_j)
  - Nests transition-based measures (use discrete X_i, Z_j based on industry/occupation)

An Aside on Size-Based Market Power

Recent interest in the role of size-based monopsony power in determining wage mark-downs

In the paper [Appendix A.5] we present an extended model that allows for

- endogenous entry
- firms with multiple jobs

Key results:

- One-job case remains the upper bound for wages; a lower bound is set by assuming firms do not compete with themselves
- The expected difference in these bounds depends on how jobs are distributed across firms

$$E\left[\overline{\omega_{ij}} - \underline{\omega_{ij}}\right] = -\sum_k \log\left(1 - p_{k,i}\right)$$

Estimation: Assumptions

$$OOI_i = -\int_j f_j^i \log f_j^i$$

- where f_j^i is the probability that i works in job j.

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Assumption: Parameterization (Dupuy & Galichon, 2014)

$$\log \frac{f_{Z|X}\left(z_j|x_i\right)}{g\left(z_j\right)} = x_i A z_j + a\left(x_i\right) + b\left(z_j\right)$$

where $a\left(X_i\right), b\left(Z_j\right)$ fix the marginal distributions

OOI is an index of concentration

- Estimated using cross-sectional distribution of similar workers
- On all observable dimensions
- Common index for unpredictability

Estimating OOI

1. Simulate observations from $f\left(X_i\right) f\left(Z_j\right)$ and define
$$Y = \begin{cases} 1 & Real\ Match \\ 0 & Simulated\ Match \end{cases}$$
2. Estimate a Logit model to recover f_j^i
$$\begin{aligned} \log \frac{P\left(Y=1|X=x,Z=z\right)}{P\left(Y=0|X=x,Z=z\right)} &= xAz + a\left(x\right) + b\left(z\right) \\ &= \frac{f\left(x_i, z_j|Y=1\right)}{f\left(x_i, z_j|Y=0\right)} \frac{P\left(Y=0\right)}{P\left(Y=1\right)} \\ &= \frac{f\left(x_i, z_j\right)}{f\left(x_i\right) f\left(z_i\right)} = f_j^i \cdot c \end{aligned}$$
3. Calculate $\widehat{f_j^i}$ for every possible worker-job combination and plug in
$$\widehat{OOI_i} = \sum_j \widehat{f_j^i} \log \widehat{f_j^i}$$

Theory

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Application: Germany

LIAB Longitudinal

- ~1% German workforce
- Cross-section: employed on 06/30/2014
- Focus on workers between 25 & 55
- Supplement with task data from BIBB (~German O*Net)
- Exploit linked establishment surveys

Descriptive Statistics

	All		Male		Female	
	Mean	SD	Mean	SD	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)
Workers						
Age	46.32	(11.64)	45.89	11.87	46.82	11.34
Female	46%	(0.50)	0%	---	1.00	---
German Citizen	98%	(0.14)	98%	0.16	0.99	(0.12)
Higher Secondary Degree	28%	(0.20)	27%	(0.20)	29%	(0.20)
Intermediate Secondary Degree	31%	(0.21)	27%	(0.20)	34%	(0.23)
Lower Secondary Degree	19%	(0.16)	19%	(0.15)	21%	(0.16)
Intermediate/Lower Education	22%	(0.17)	27%	(0.20)	16%	(0.14)
Daily Earnings	87.30	(51.23)	104.27	(50.87)	67.3	(43.90)
Distance	12.90	(39.15)	15.80	(43.71)	9.49	(32.64)
Jobs						
Establishment size	1547.75	(7665.13)	2183.74	(9368.63)	797.77	(4847.42)
Sales per worker in 2013 (€)	165341	(187464.80)	193785	(199633.30)	131798	(165859.70)
Part-time contract	31%	(0.46)	12%	(0.33)	53%	(0.50)
Observations	411,408		262,995		148,413	

Women Work Closer To Home

	Distance (Miles) (1)	<5 Miles (2)	5-20 Miles (3)	20-50 Miles (4)	50+ Miles (5)
All	12.9	73.45%	15.51%	6.34%	4.71%
Male	15.8	69.28%	17.23%	7.37%	6.11%
Female	9.5	78.36%	13.48%	5.13%	3.02%
Higher Secondary Degree	22.1	62.50%	19.42%	9.10%	8.98%
Intermediate Secondary Degree	9.9	77.05%	13.97%	5.76%	3.20%
Lower Secondary Degree	9.4	77.78%	13.46%	5.58%	3.18%
Intermediate/Lower Education	8.0	79.04%	14.42%	4.08%	2.48%

Baseline Measure of OOI

- X_i: quadratic in age, female, PCA components for training occupation PCA
- Z_j:
  - Indicators for part-time/full-time, temp agency job, fixed term contract
  - PCA components for occ & industry, indicators for occupational complexity PCA
  - Establishment characteristics: size, share of females in management
  - PCA based on establishment survey: business performance, investments, working hours, firm training, vocational training, "general"
- Distance: miles between worker's previous residence to establishment (400 districts)

Theory

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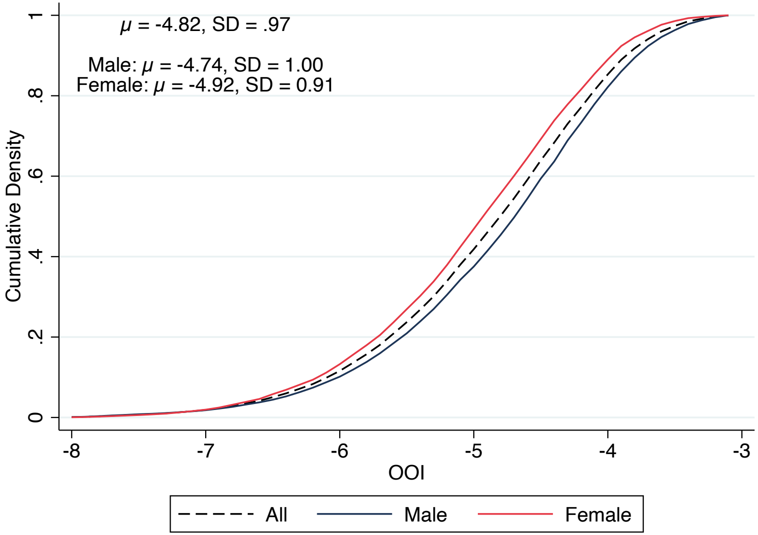
Distribution of OOI



Mass Layoff Exercise

- Involuntary job separations force workers to move to their outside options
- We use mass layoffs to show that the OOI is a meaningful measure of outside options
- We focus on workers who:
  - Separated from their establishment between 1993-2014
  - At an establishments with at least 50 workers
  - At an establishments whose workforce declined 30% over the year
  - With at least 3 years of tenure pre mass-layoff
  - Are below age 55

Mass Layoff Sample

	Main Sample		Mass Layoff Sample	
	Mean	SD	Mean	SD
	(1)	(2)	(3)	(4)
Workers				
Age	46.32	(11.64)	38.64	(10.62)
Female	0.46	(0.50)	0.40	(0.49)
German Citizen	0.98	(0.14)	0.98	(0.14)
Higher Secondary Degree	28%	(0.20)	18%	(0.15)
Intermediate Secondary Degree	31%	(0.21)	23%	(0.18)
Lower Secondary Degree	19%	(0.16)	20%	(0.16)
Intermediate/Lower Education	22%	(0.17)	39%	(0.24)
Daily Earnings	87.30	(51.23)	66.35	(85.93)
Workers	411,408		13,404	

Outside Options and Mass Layoffs

- We compare workers within the same mass-layoff event $\psi_{j(i),t}$
- With different OOI_i

$$\widetilde{w}_{i,t} = \frac{w_{i,t}}{w_{i,0}} = \sum_{\tau=0}^{36} \lambda_\tau OOI_i + \psi_{j(i),t} + \mu_t X_{it} + \nu_{i,t}, \quad (2)$$

$$e_{i,t} = \sum_{\tau=0}^{36} \lambda_\tau^{\mathrm{emp}} OOI_i + \psi_{j(i),t}^{\mathrm{emp}} + \mu_t^{emp} X_{it} + \nu_{i,t}^{\mathrm{emp}}, \quad (3)$$

Mass Layoffs and Relative Wages

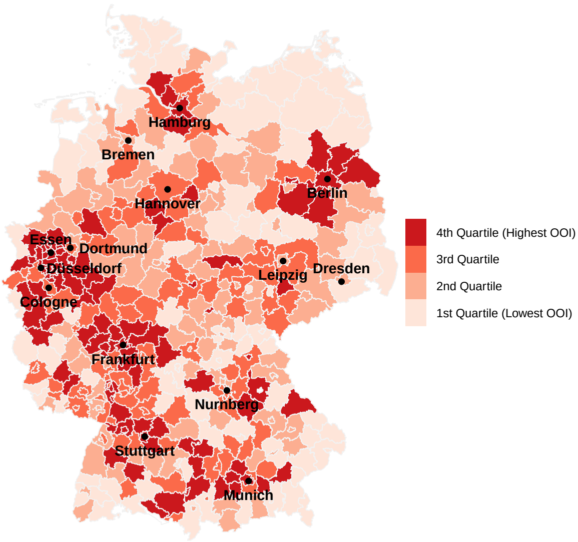
	(1)		(2)		(3)		(4)	
3 Months (λ_3)	0.071	***	0.071	***	0.067	***	0.068	***
	(0.022)		(0.022)		(0.023)		(0.023)	
6 Months (λ_6)	0.089	***	0.089	***	0.083	***	0.083	***
	(0.024)		(0.024)		(0.026)		(0.027)	
12 Months (λ_{12})	0.103	***	0.102	***	0.089	***	0.088	***
	(0.027)		(0.027)		(0.031)		(0.031)	
24 Months (λ_{24})	0.109	***	0.109	***	0.079	**	0.075	**
	(0.034)		(0.034)		(0.036)		(0.036)	
Establishment-Month FE	✓		✓		✓		✓	
Tenure			✓		✓		✓	
Age					✓		✓	
Education					✓		✓	
Gender					✓		✓	
Training Occupation Characteristics							✓	
Observations	547,353		547,353		547,353		547,353	
Workers	13,404		13,404		13,404		13,404	

Mass Layoffs and Employment

	(1)		(2)		(3)		(4)	
3 Months (λ_3)	0.016	***	0.016	***	0.013	**	0.012	**
	-(0.005)		-(0.005)		-(0.006)		-(0.006)	
6 Months (λ_6)	0.008		0.008		0.004		0.002	
	-(0.006)		-(0.006)		-(0.006)		-(0.006)	
12 Months (λ_{12})	0.016	**	0.016	**	0.009		0.007	
	-(0.006)		-(0.006)		-(0.007)		-(0.007)	
24 Months (λ_{24})	0.017	***	0.017	***	0.011		0.007	
	-(0.007)		-(0.007)		-(0.007)		-(0.007)	
Establishment-Month FE	✓		✓		✓		✓	
Tenure			✓		✓		✓	
Age					✓		✓	
Education					✓		✓	
Gender					✓		✓	
Training Occupation Characteristics							✓	
Observations	547,353		547,353		547,353		547,353	
Workers	13,404		13,404		13,404		13,404	

Graph

Geographic Variation



Distribution of the OOI

	Mean	SD	Quantiles		
			25th	50th	75th
	(1)	(2)	(3)	(4)	(5)
All	-4.82	0.97	-5.37	-4.70	-4.14
Male	-4.74	1.00	-5.28	-4.59	-4.05
Female	-4.92	0.91	-5.47	-4.83	-4.27
Citizen	-4.82	0.95	-5.36	-4.70	-4.14
Non-Citizen	-5.10	1.37	-5.52	-4.86	-4.34
Higher Secondary Degree	-4.58	0.92	-5.01	-4.45	-3.99
Intermediate Secondary Degree	-4.76	0.87	-5.32	-4.67	-4.11
Lower Secondary Degree	-4.91	0.95	-5.47	-4.80	-4.22
Intermediate/Lower Education	-5.14	0.93	-5.69	-5.08	-4.46

Heterogeneity in the OOI

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Female	-0.295 ***	-0.268 ***	-0.283 ***	-0.255 ***	-0.201 ***	-0.237 ***	-0.344 ***
	(0.009)	(0.011)	(0.007)	(0.008)	(0.008)	(0.008)	(0.009)
Non-Citizen	-0.262 ***	-0.226 ***	-0.553 ***	-0.498 ***	-0.539 ***	-0.494 ***	-0.675 ***
	(0.036)	(0.032)	(0.030)	(0.026)	(0.022)	(0.020)	(0.025)
Lower-Secondary Certificate	-0.601 ***	-0.535 ***	-0.526 ***	-0.474 ***	-0.504 ***	-0.464 ***	-0.374 ***
	(0.014)	(0.014)	(0.011)	(0.010)	(0.011)	(0.010)	(0.010)
Intermediate	-0.236 ***	-0.211 ***	-0.110 ***	-0.110 ***	-0.129 ***	-0.129 ***	-0.098 ***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)
Age Controls	Quadratic	Quadratic	Quadratic	Quadratic	Quadratic	Quadratic	Quadratic
Training Occupation FE		✓		✓		✓	✓
District FE			✓	✓			✓
Establishment FE					✓	✓	
OOI Based on Vacancies							✓
Adjusted R-Squared	0.133	0.253	0.530	0.629	0.573	0.627	0.562
Observations	375,765	375,765	375,765	375,765	375,765	375,765	375,765

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Outside Options and Wage Inequality

Linking OOI and Wages

$$\log w_i = \alpha OOI_i + \beta X_i + \varepsilon_i$$

1. Endogeneity: OOI is an equilibrium object, correlated with worker productivity
2. Measurement error: OOI is measured with noise

Measure link between outside options and wages using instruments that change workers' option sets

- Ideal instrument holds firm profits constant
- Use a standard shift-share instrument, explore robustness with exporting firms

Shift-Share OOI

Idea: Compare workers in the same industry with outside options in different industries

Specification: Look at change in wages 2004-2014 within industries (j)

Instrument Construction

$$\begin{aligned} \Delta_{04}^{14} \log w_i &= \alpha \Delta_{04}^{14} OOI_i && + \beta \Delta_{04}^{14} X_i + Ind_{j(i,2004)} + \upsilon_i \\ \Delta_{04}^{14} OOI_i &= \gamma Z_{j(i,2004),r(i,2004)} && + \delta \Delta_{04}^{14} X_i + Ind_{j(i,2004)} + \epsilon_i, \end{aligned} \tag{4}$$

where Z_j is the expected change in OOI for individuals in industry j and region r in 2004

ID: exogeneity of shocks

$$E\left[\varepsilon_i Z_{j(i,2004),r(i,2004)} | Ind_{j(i)}^{04}, \Delta_{04}^{14} X_i\right] = 0$$

Shift-Share OOI: Instrument Details

1. Calculate the predicted OOI for each individual

$$\widetilde{OOI}_{i,2014} = -\sum_{z_j} \widehat{f_{Z|X}(z_j|x_i)} \left(\frac{\log \widehat{f_{Z|X}(z_j|x_i)}}{\log \widetilde{g}_{14}(z_j)} \right)$$

2. Calculate the predicted change in OOI

$$\Delta_{04}^{14}\widetilde{OOI}_i = \widetilde{OOI}_{i,2014} - OOI_{i,2004}$$

3. Average across individuals in region j and industry r in 2004

$$Z_{j,r} = \frac{1}{|\mathcal{S}(j,r)|} \sum_{i \in \mathcal{S}(j,r)} \Delta_{04}^{14}\widetilde{OOI}_i$$

Shift-Share Results

	Full Sample			By Exporting Share of Sales: More than 33%	By Exporting Share of Sales: Between 1 and 33%	By Exporting Share of Sales: Less than 1%
	(1)	(2)	(3)	(4)	(5)	(6)
First Stage	0.299 ***	0.276 ***	0.242 ***	0.353 ***	0.204 ***	0.272 ***
	(0.064)	(0.048)	(0.064)	(0.104)	(0.059)	(0.080)
Reduced Form	0.0517 **	0.0504 **	0.038	0.080 ***	0.009	0.031
	(0.021)	(0.021)	(0.024)	(0.026)	(0.026)	(0.023)
2SLS	0.173 ***	0.183 ***	0.156 *	0.227 ***	0.046	0.114
	(0.063)	(0.068)	(0.092)	(0.071)	(0.123)	(0.096)
Industry FE	✓	✓	✓	✓	✓	✓
Age Controls	✓	✓	✓	✓	✓	✓
Demographic Controls		✓	✓			
Regional Controls			✓			
F (First Stage)	21.95	32.82	14.5	11.52	12.04	11.56
Number of industry-regions	5510	5510	5510	2195	2525	790
Observations	435,586	435,586	435,586	144,039	147,529	144,018

Shift-Share Heterogeneity

	By Gender		By Education		
	Male	Female	Higher Secondary	Intermediate Secondary	Lower Secondary
	(1)	(2)	(3)	(4)	(5)
First Stage	0.309 ***	0.266 ***	0.232 ***	0.203 ***	0.321 ***
	(0.080)	(0.050)	(0.079)	(0.053)	(0.049)
Reduced Form	0.0673 ***	0.019	0.031	0.046 **	0.080 ***
	(0.021)	(0.022)	(0.022)	(0.022)	(0.026)
2SLS	0.218 ***	0.071	0.134	0.228 **	0.247 ***
	(0.059)	(0.086)	(0.099)	(0.103)	(0.078)
Industry FE	✓	✓	✓	✓	✓
Age Controls	✓	✓	✓	✓	✓
F (first stage)	14.77	27.97	8.56	14.89	43.45
Observations	283,550	152,036	96,148	148,136	91,793

Decomposing Wage Gaps

1. Baseline: Raw wage gap

$$\log w_i = \beta_0 X_i + \epsilon_i$$

   - Mincer regression of log wages on demographic characteristics: indicators for each education group, a quadratic function of age, gender, citizenship status, part-time indicators

2. Wage gap explained by the OOI:

$$\log w_i = \underbrace{\widehat{\alpha}}_{.17} OOI_i + \beta_1 X_i + \nu_i$$

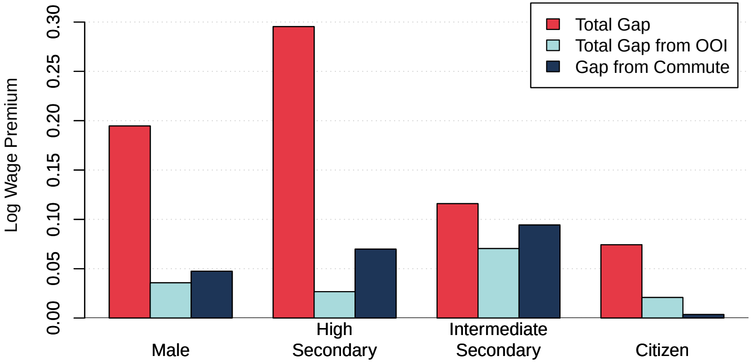
3. Wage gap explained by commuting costs:

$$\log w_i = \underbrace{\hat{\alpha}}_{.17} \left(\mathrm{OOI}_i - \widetilde{OOI}_i\right) + \beta_2 X_i + \epsilon_i$$

Note: to account for top-coding, we estimate each equation using a Tobit model

Wage Gaps and Distance

- Assign everyone the "commuting cost" or a 40 year old male citizen with highest level of education



Discussion

- Developed a method to estimate workers' outside employment opportunities
  - Adapted standard marriage market models for use in the labor market (Becker 1973, Shapley-Shubik 1971)
  - Derived a sufficient statistic for outside options: Outside Options Index (OOI)
- Applied this approach to linked employer-employee data from Germany
  - Males, German citizens, urban residents have more options
  - 10% more options yields 1.7% higher income
- Differences in options tend to increase between-group wage inequality: 20% of gender gap

Thank You

Appendix

Solution: Equilibrium

Stable equilibrium (core allocation) includes:

1. Allocation of workers and jobs $m : \mathcal{I} \to \mathcal{J}$
2. Transfers w_{ij}

Which satisfies the following conditions:

1. No profitable deviations $\forall i \in \mathcal{I}, \forall j \in \mathcal{J}$:

$$\underbrace{\omega_{i,m(i)}}_{\substack{i \text{ Equilibrium} \\ \text{compensation}}} + \underbrace{\pi_{m^{-1}(j),j}}_{\substack{j \text{ Equilibrium} \\ \text{profit}}} \geq \underbrace{\tau_{ij}}_{\substack{i,j \text{ potential} \\ \text{value produced}}}$$

2. Participation constraint

$$\begin{aligned} \forall i \in I &: \quad \omega_{i,m(i)} \geq u_i \\ \forall j \in J &: \quad \pi_{m^{-1}(j),j} \geq v_j \end{aligned}$$

where u_i, v_j are the value of unemployment or vacancy Return

Continuous Logit Assumptions

$$\tau_{ij} = \tau\left(x_i, z_j\right) + \varepsilon_{i,z_j} + \varepsilon_{j,x_i}$$

$$\text{s.t.} \qquad \varepsilon_{i,z_j} \perp \varepsilon_{j,x_i}$$
$$\varepsilon_{i,z_j}, \varepsilon_{j,x_i} \sim CL\left(\alpha\right)$$

- Each worker (job) knows about a random subset of the available jobs (workers)
- For each of these jobs (workers), the relevant party draws ϵ from a Poisson process on $\mathcal{Z}\times\mathbb{R}$ with intensity
$$f\left(z\right) dz \times e^{-\varepsilon} d\varepsilon$$
- The maximum value on each Borel measurable subset is EV_1 with scale α

Return

Continuous Logit Choice

$Q_{z_j|x_i}$ is the measure of x_i times their share that chooses z_j.

$$Q_{z_j|x_i} = f(x_i) f(z_j|x_i)$$

In continuous logit the share to choose z_j is

$$\frac{\exp \omega(x_i, z_j) f(z_j)}{\int_{z'} \exp \omega(x_i, z') f(z') dz'} = \frac{\exp \omega(x_i, z_j) f(z_j)}{\exp E[\omega_i|x_i]}$$

Market clears when

$$Q_{z_j|x_i} = \frac{\exp \omega(x_i, z_j) f(z_j) f(x_i)}{\exp E[\omega_i|x_i]} = \frac{\exp \pi(x_i, z_j) f(z_j) f(x_i)}{\exp E[\pi_j|z_j]} = Q_{x_i|z_j}$$

$$\omega(x_i, z_j) - \pi(x_i, z_j) = E[\omega_i|x_i] - E[\pi_j|z_j]$$

By definition

$$\omega(x_i, z_j) + \pi(x_i, z_j) = \tau(x_i, z_j)$$

And the sum gives the solution

Return

PCA Components for Occupations

	N	First Component	Second Component
Hours	11021	Work on Sundays and public holidays	Hours per week like to work
Type of Task	15035	Have responsibility for other people	Cleaning, waste, recycling
Requirements	10904	Face acute pressure and deadlines	Highly specific regulations
Physical	20036	Oil, dirt, grease, grime	Pathogens, bacteria
Mental	17790	Support from colleagues	Often missing information about work

Return

PCA Components from Estab. Survey (Z)

	N	First Component	Second Component
Business Performance	8824	Member of chamber of industry	Profit
Investment & Innovation	8824	IT investment	Total investment
Hours	8824	Vacation credit policy	Flexible hours
Vocational Training	8824	Offer apprenticeship	Ability to fill training
General	8824	Family managed	Staff representation

Return

Proof

$$f_j^i = f\left(j|i\right) = f\left(j|X = x_i\right) =$$

$$= f\left(j|Z = z_j, X = x_i\right) f\left(Z = z_j|X = x_i\right) =$$

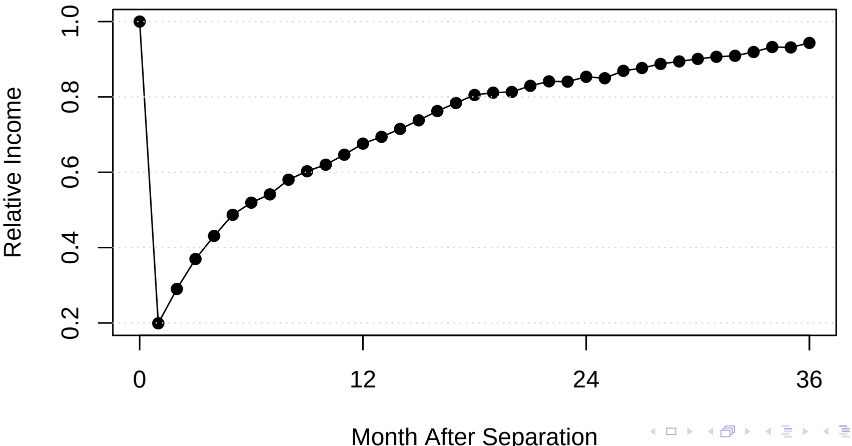
$$= f\left(j|Z = z_j\right) \frac{f\left(X = x_i, Z = z_j\right)}{f\left(X = x_i\right)} =$$

$$= \frac{|J|^{-1}}{f\left(Z = z_j\right)} \frac{f\left(X = x_i, Z = z_j\right)}{f\left(X = x_i\right)}$$

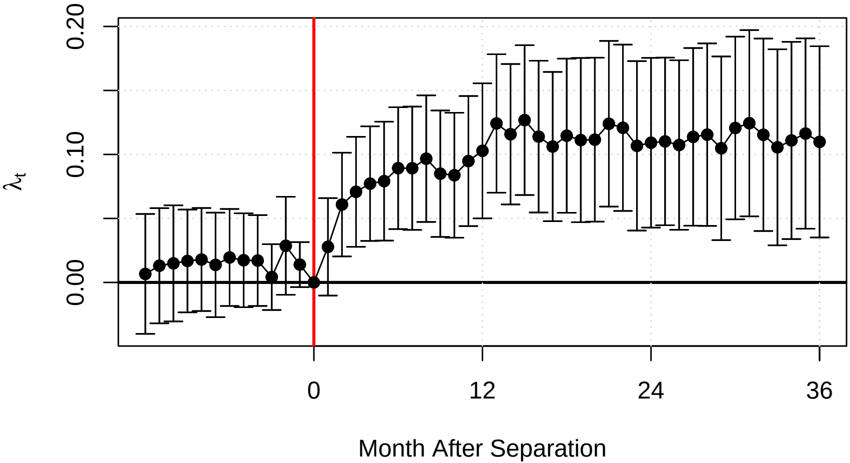
Return

Mass-Layoffs

- **Outcome variable**: Daily wage divided by baseline $\frac{w_t}{w_0}$

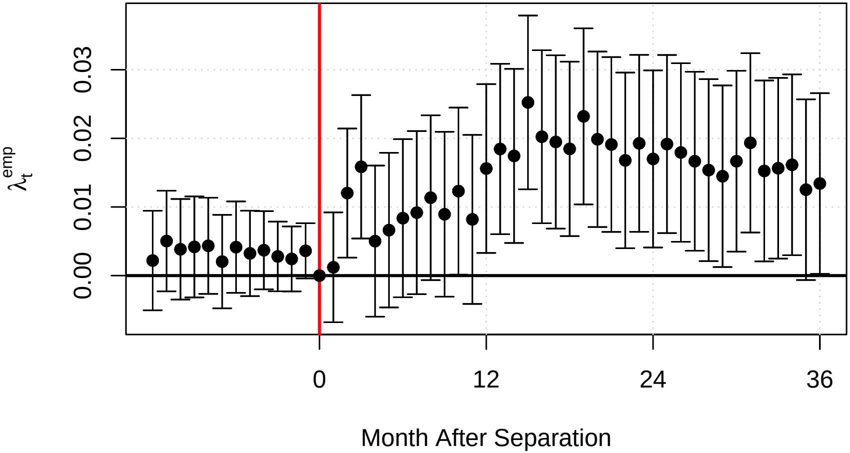


Mass-Layoffs: Relative Income



Table

Mass Layoffs - Job Search



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