Worker Beliefs About Outside Options

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What Do Workers Know About Their Outside Options?

Starting point:

- Across firms and jobs, large wage differences between similar workers
  Slichter (1950); Abowd, Kramarz and Margolis (1999); Card, Heining and Kline (2013); Bonhomme, Holzheu, Lamadon, Manresa, Mogstad and Setzler (2020)

How can these differences persist in equilibrium?

- Compensating differentials
  Rosen (1986)
- Heterogeneity in preferences
  Card, Cardoso, Heining and Kline (2018); Berger, Herkenhoff and Mongey (2022); Lamadon, Mogstad and Setzler (2021)
- Search/switching costs
- Misperceptions

Our Paper: Workers' Subjective vs. Objective Outside Options

We ask:

1. Do workers accurately perceive wage differences across firms?
2. How systematic are workers' biases about outside options with other employers?
3. What are equilibrium consequences of misperceptions about outside options?

Our Paper: Workers' Subjective vs. Objective Outside Options

- Representative survey of workers' beliefs about their outside options
  - Integrated into German Socio-Economic Panel (GSOEP)
  - Linked to respondents' administrative labor market data (IAB)

- Compare subjective beliefs with (proxies for) objective outside options
  - Wage changes of coworkers when they move out of the firm
  - External labor market: wages of workers in the same occupation

- Experiment (in separate, follow-up survey): information treatment about average wage of similar workers in respondent's labor market cell

Our Paper: Preview of Main Results

- Workers have systematic misperceptions about outside options
  - Workers mistakenly believe outside options are similar to current employment conditions ("anchoring")
  - Workers, especially at low-paying firms, underestimate their outside options.

- Analyze equilibrium consequences of worker misperception in very simple labor market model

  Adopt and extend product market framework in Salop and Stiglitz (1977) to labor market and allow for misperceptions (anchoring)

  - Key insight: Misperceptions can be source of monopsony, wage markdowns, and labor market segmentation.

    Formalization of Robinson's (1933) insight
  - Evaluate model predictions in the data

Literature:

Reynolds (1951): survey of 1,000 manual workers in New Haven labor market (1946-48)

- "Very few [workers] knew [...] how much they could expect to earn [at other plants]"
- Workers at low-paying firms underestimate wages elsewhere

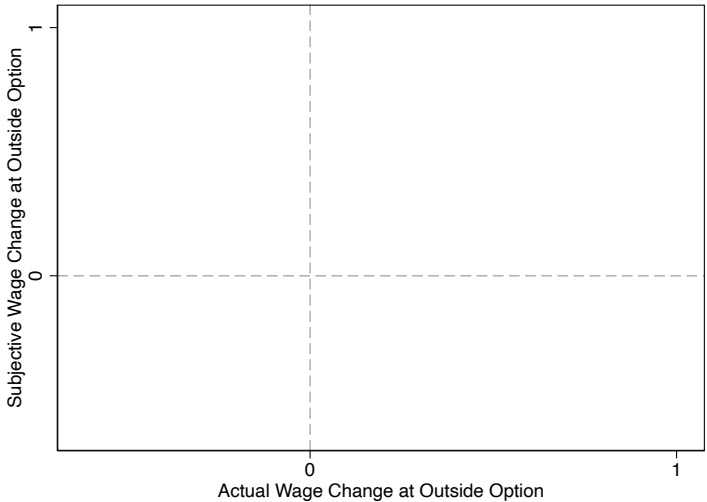
Growing literature on **labor market expectations** (Faberman, Mueller, Şahin and Topa, 2017; DellaVigna, Lindner, Reizer and Schmieder, 2017; DellaVigna, Heining, Schmieder and Trenkle, 2020; Mueller, Spinnewijn and Topa, 2021)

- Survey on job-seekers' beliefs about, e.g., **future wage offers** (Conlon, Pilossoph, Wiswall and Zafar, 2018) or **future job finding rates** (Spinnewijn, 2015; Mueller and Spinnewijn, 2021)
- Limited information even about **coworker wages** (Card, Mas, Moretti and Saez, 2012; Cullen and Perez-Truglia, 2018)

Our paper:

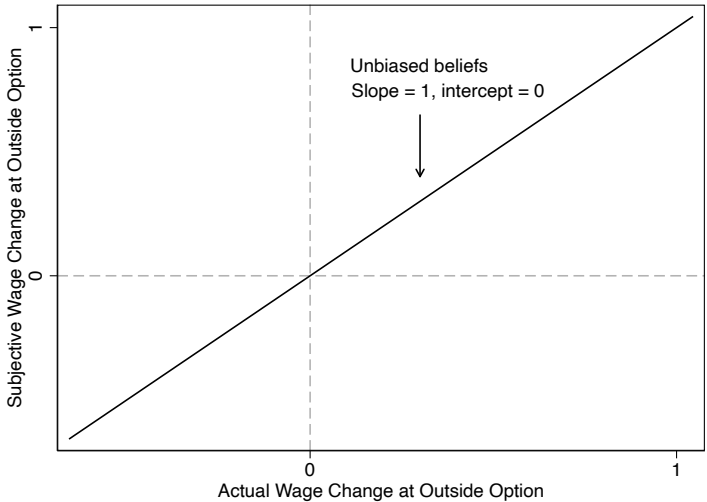
- Direct measure of beliefs about outside options
- Comparisons to objective benchmarks in admin data
- Experimental shifter of beliefs
- Model-guided analysis of equilibrium consequences

Research Design: Subjective vs. Objective Outside Options



▸ Microfoundation: Bayesian Learning Model

Research Design: Subjective vs. Objective Outside Options



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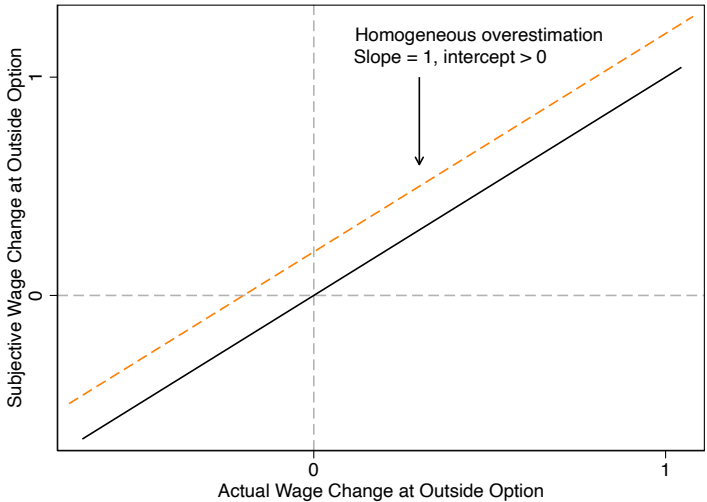

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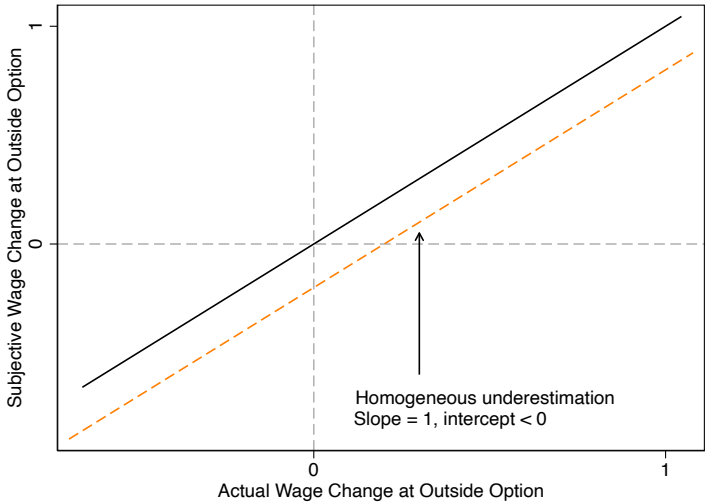

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Research Design: Subjective vs. Objective Outside Options

▸ Microfoundation: Bayesian Learning Model

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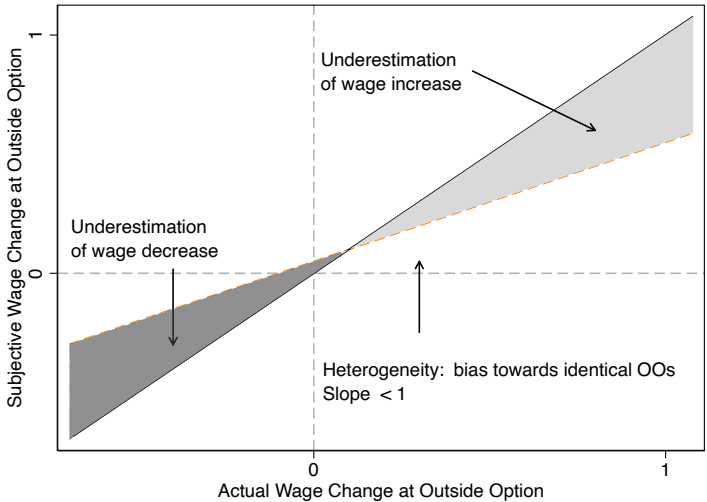
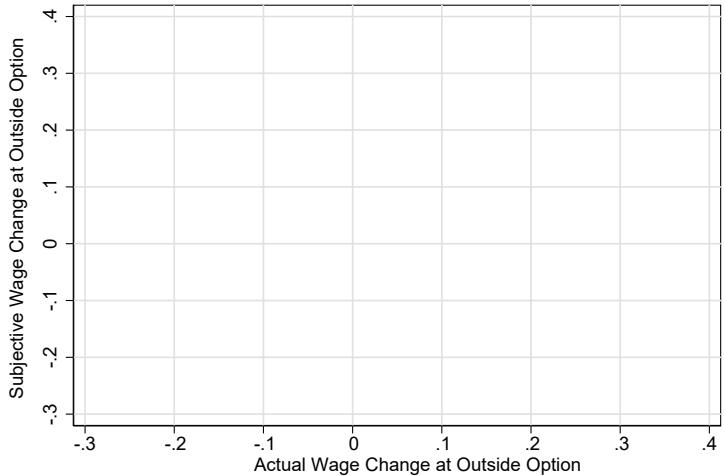
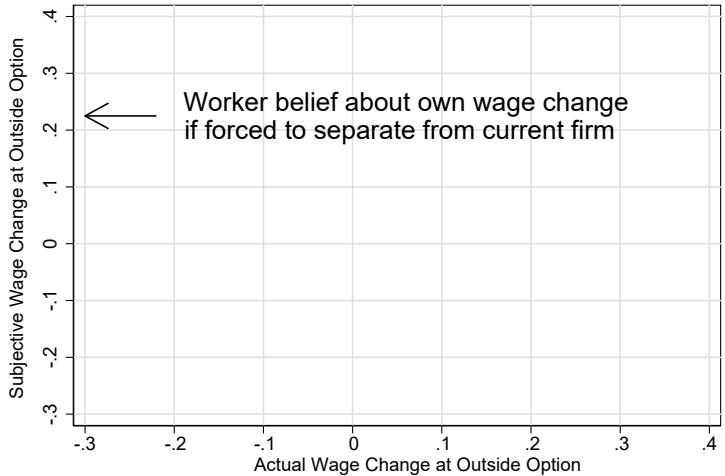


▸ Microfoundation: Bayesian Learning Model

Research Design: Implementation



Research Design: Beliefs



Survey Measure of Beliefs about Outside Options

Imagine that you were forced to leave your current job and that you had 3 months to find a job at another employer in the same occupation. Do you think that you would find a job that would offer you a higher overall pay, the same pay, or a lower pay?

If previous answer is not "Same pay": What do you think: how much more/less would you earn in that new job? ⇒ Worker Belief about Outside Option

▸ Histogram of Responses ▸ Alternative Elicitations

- Elicit other belief data:
  - Wage changes of coworkers who left the firm
  - Rank in within-occupation wage distribution
  - Median salary in occupation in external labor market

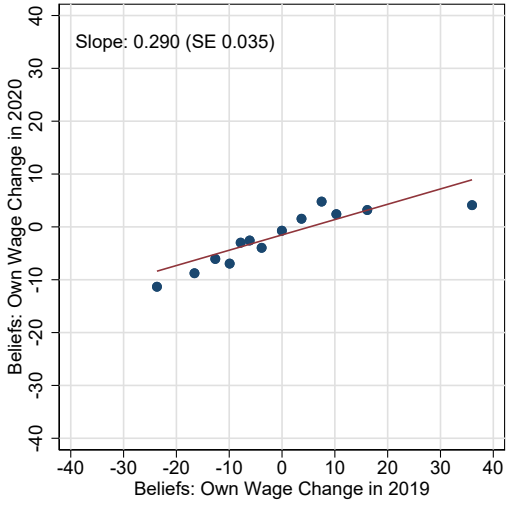
Integrate this Q + custom questionnaire into GSOEP (2019, 2020 waves) & link to administrative matched employer-employee data (SOEP-ADIAB)

German Socio-Economic Panel (GSOEP)

- Representative, probability-based sample of German population
- High quality: face-to-face or computer-aided telephone interviews
- We included our tailored survey module in the 2019 and 2020 waves of the GSOEP Innovation Sample
- 1,604 respondents, with panel structure across the two waves ▸ Sample Characteristics
- Link to administrative matched employer-employee data (SOEP-ADIAB)
  - SOEP respondents asked for consent for linkage
  - Match rate of 87% (based on names, gender, date of birth, and address)

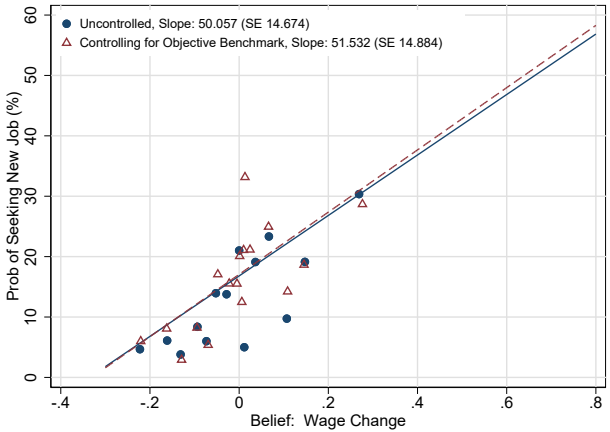
Additional surveys: academic experts & additional survey for robustness checks

Validation I: Beliefs are Persistent



▸ In Euros

Validation II: Beliefs Predict Intentions to Search

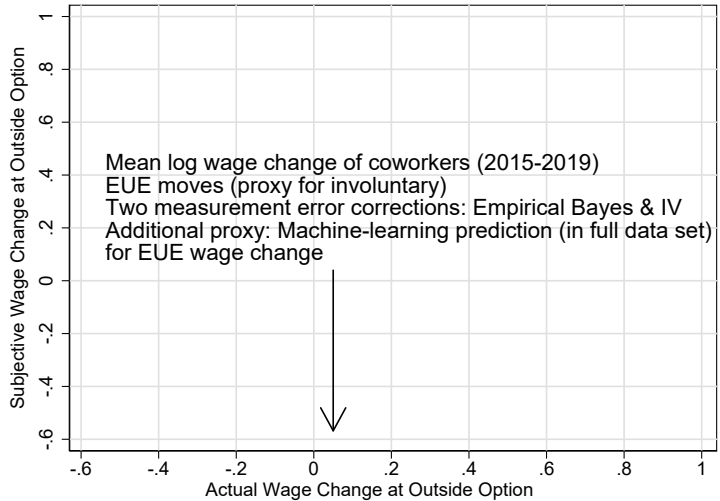


▸ Reservation Wage Cut ▸ Intentions to Bargain ▸ Bargaining Magnitude

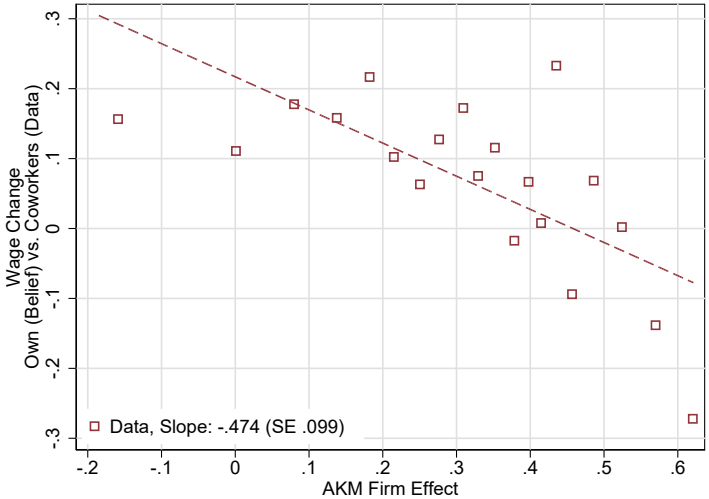
Robustness Checks: Beliefs

- Drop respondents who report "same pay" ▸ Main Results w/ this Restriction
- Elicit beliefs without "same pay" option ▸ Response Distribution
- Do not condition on staying in occupation ▸ Response Distribution
- Vary time horizon of search ▸ Response Distribution
- Vary reason for separation ▸ Response Distribution

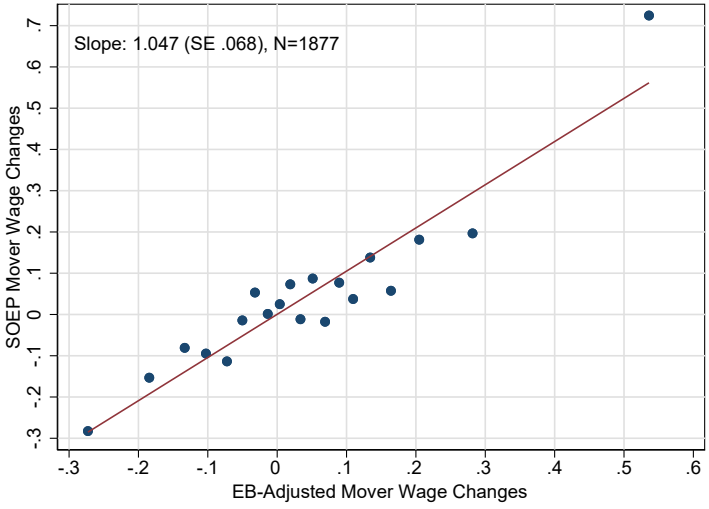
Research Design: Objective Proxy



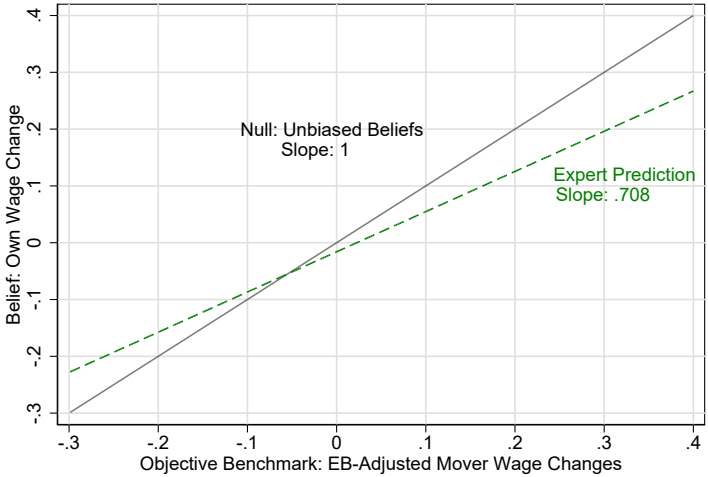
Coworker Wage Changes Correlated with Firm AKM Effect



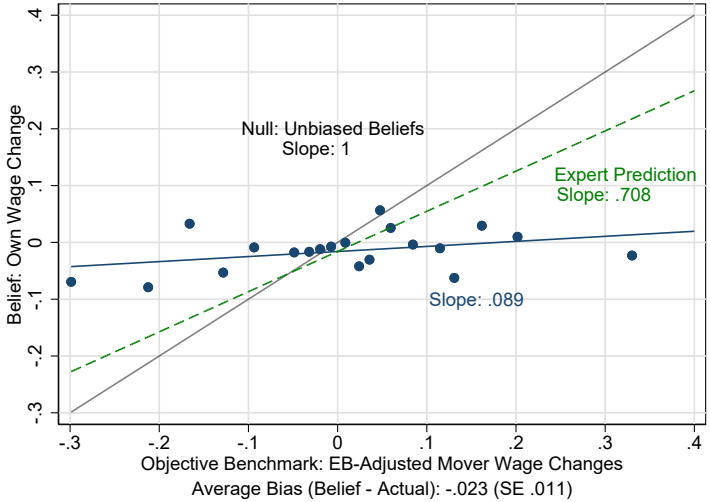
Coworker Wage Changes Predictive of Past GSOEP Wage Changes



Research Design: Expert Prediction

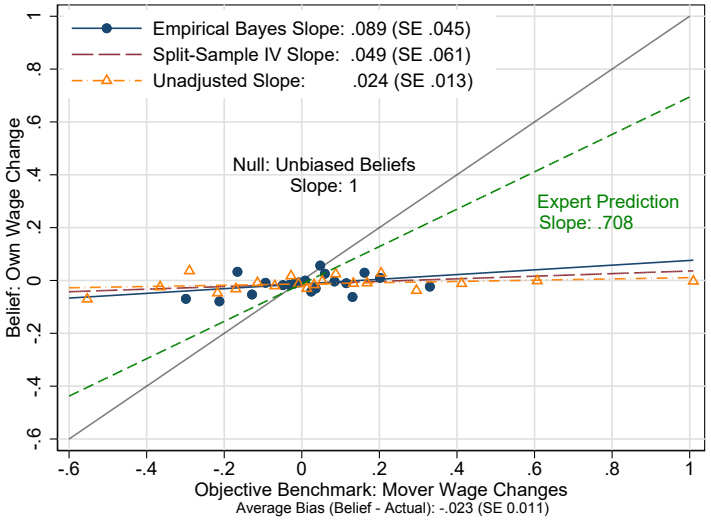


Results



▸ Empirical Bayes Methodology

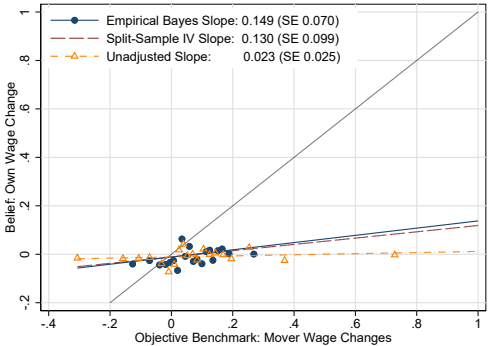
Results



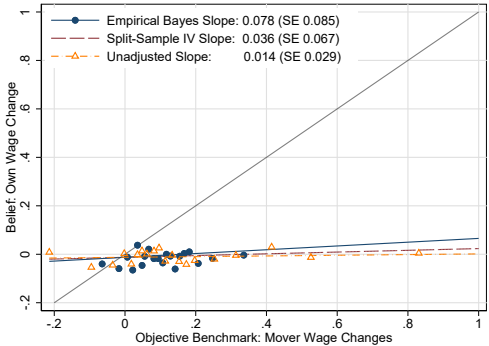
▸ EB Methodology ▸ IV First Stage ▸ Median ▸ Diff Time Horizon ▸ 20+ Moves ▸ Excluding "Same Wage" ▸ Own Wage Change Question

1. Alternative Set of Coworkers

(a) Same Education



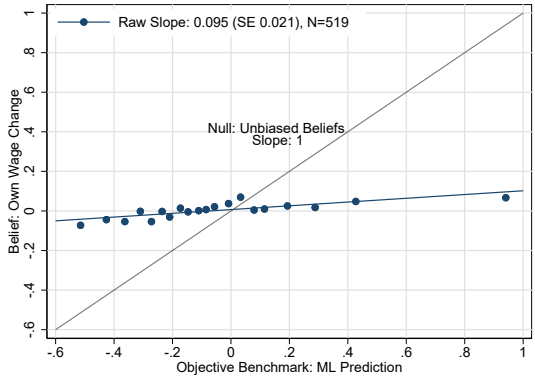
(b) Same Occupation



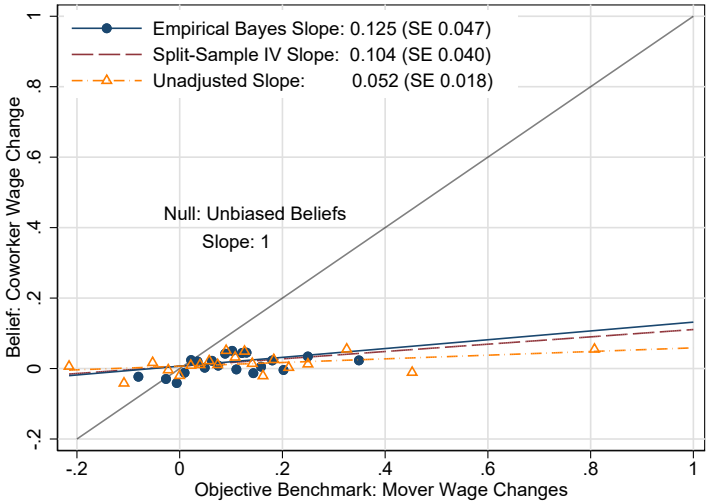
▸ 20+ Coworker Moves ▸ Same Age / Same Income ▸ AKM Involuntary Movers

2. Alternative, Richer OO Prediction: ML Estimation

- Predict GSOEP respondents' wage changes if they left their current firm, based on a rich set of covariates
- Estimate a Lasso model of log wage change of "involuntary" (EUE) movers ▸ Methodology

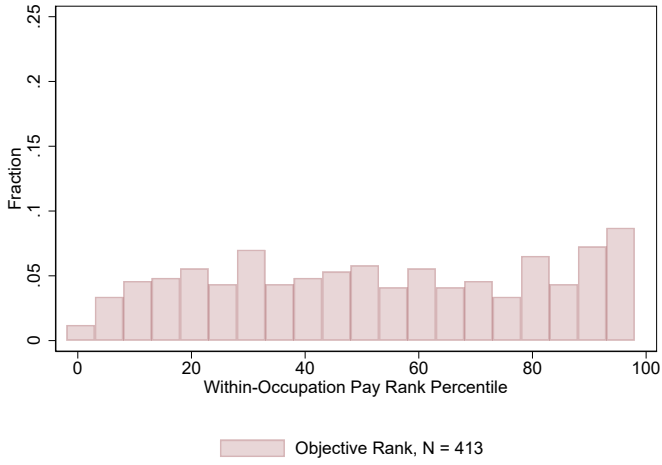


3a. Alternative Comparison: Coworkers' Wage Changes if Moving Out



▸ IV First Stage ▸ Median ▸ Diff Time Horizon ▸ 20+ Moves ▸ Excluding "Same Wage" ▸ Question

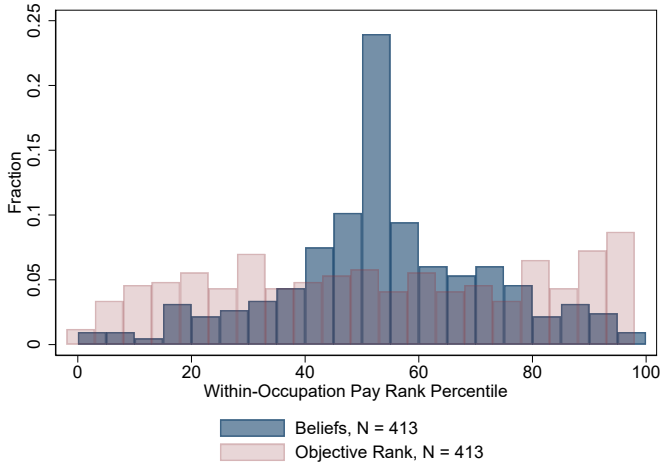
3b. Alt. Comparison: Own Rank in Occupation (Truth)



Red bars plot actual pay rank in occupation, calculated using admin ADIAB data and 4-digit occupation codes.

▸ Question

3b. Alt. Comparison: Own Rank in Occupation (Beliefs vs. Truth)

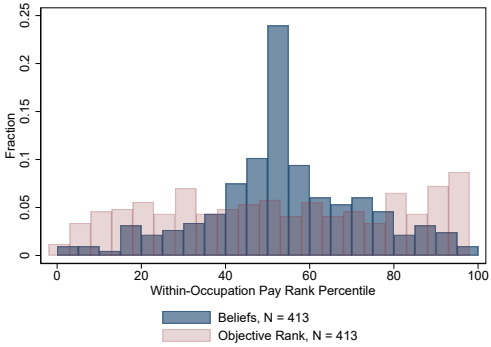


Red bars plot actual pay rank in occupation, calculated using GSOEP data and 4-digit occupation codes.

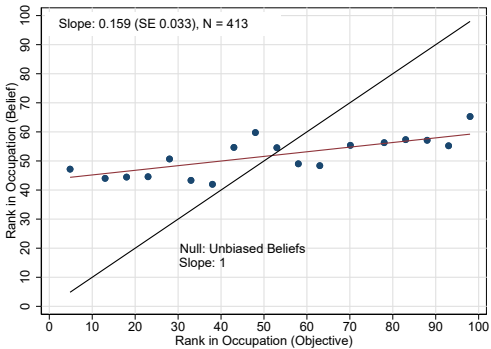
▸ Question

3b. Alt. Comparison: Own Rank in Occupation (Beliefs vs. Truth)

(a) Belief Distribution



(b) Belief vs Actual Rank



Red bars plot actual pay rank in occupation, calculated using GSOEP data and 4-digit occupation codes.

▸ Question

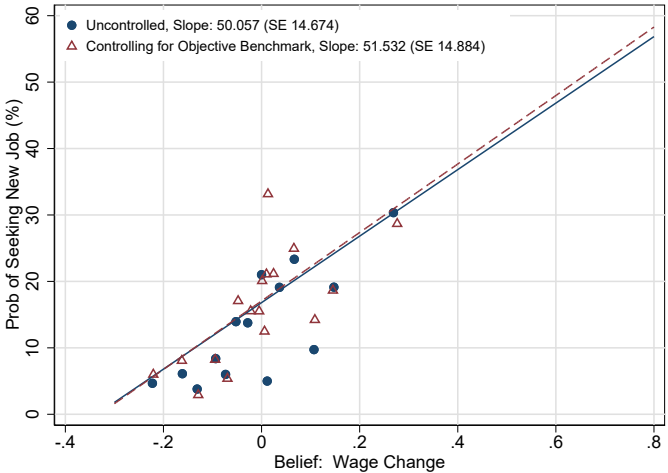
Taking Stock: Comparing Subjective and Objective Outside Options

- Systematic misperceptions of own and coworker wage changes: **"anchoring"** beliefs about OO on current wage.
- Consistent with workers perceiving (relevant) external labor market to be more similar to current job/employer than it actually is – and using their current (jobs/employer's) wage as a signal about the overall labor market ▸ Bayesian Learning Model
  - Anchoring-and-adjustment heuristic (Kahneman and Tversky, 1974)

Next:

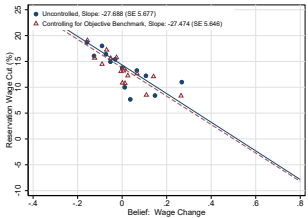
- **Do beliefs correlate with intended labor market behaviors?**
- **Does providing workers with information change their labor market behavior?**

Beliefs Correlate With Intentions to Search

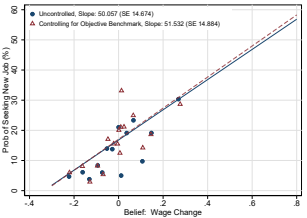


Beliefs Correlate With Intended Labor Market Behavior

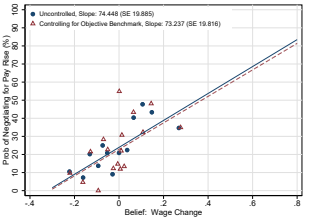
(a) Reservation Wage Cut



(b) Search for New Job



(c) Negotiate for Higher Pay



▸ Intentions on Mover Wage Changes

Information Provision Experiment (Pre-registered)

- In GSOEP-IS sample: underpowered experiment (didn't shift beliefs ⇒ no first stage?)
  ▸ Results ▸ Results II
- New experiment: online survey of ≈ 3,000 German respondents in full-time employment
- Professional survey companies (Bilendi, Dynata)
- Elicit beliefs about mean wage of observably similar peers
  - Workers of the same gender, age, education, labor market region, 5-digit occupation
- Information treatment: randomly provide 50% of respondents with the objective mean wage of similar worker
- Study effects on
  - beliefs about outside options
  - intended labor market behaviors

Information Treatment Screen

Information about the Wages of Workers with Similar Characteristics to You

You have estimated that other people with your characteristics earn **2800 dollars** per month.

Based on data from the Federal Employment Agency, we have calculated how much people with your characteristics actually earn per month.

Employees with your characteristics earn an average of **4097 dollars** per month.

Information Treatment Screen

Information about the Wages of Workers with Similar Characteristics to You

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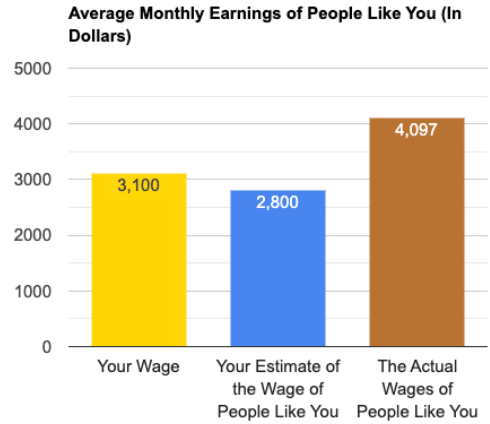


Information Treatment Screen

(a) Treatment Group

Information about the Wages of Workers with Similar Characteristics to You

You have estimated that other people with your characteristics earn **2800 dollars** per month.

Based on data from the Federal Employment Agency, we have calculated how much people with your characteristics actually earn per month.

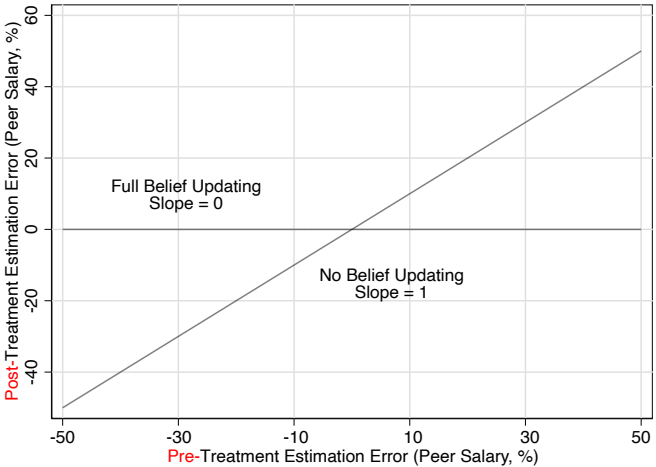
Employees with your characteristics earn an average of **4097 dollars** per month.

(b) Control Group

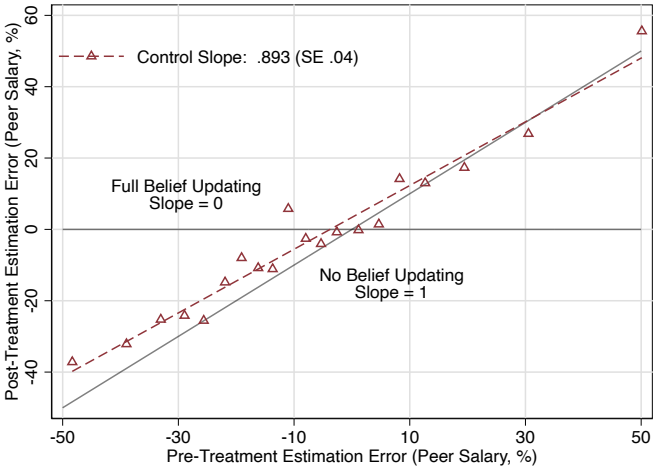
Your Guess

You have estimated that other people with your characteristics earn **2800 dollars** per month.

Validation Check: The Information Treatment Reduces the Estimation Error About Peer Salary



Validation Check: The Information Treatment Reduces the Estimation Error About Peer Salary



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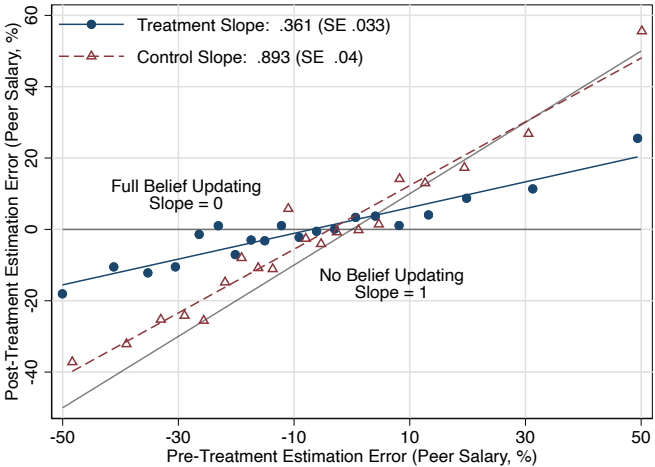
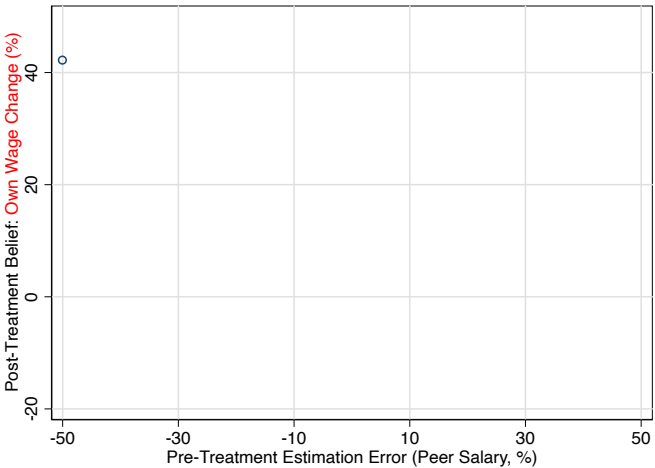
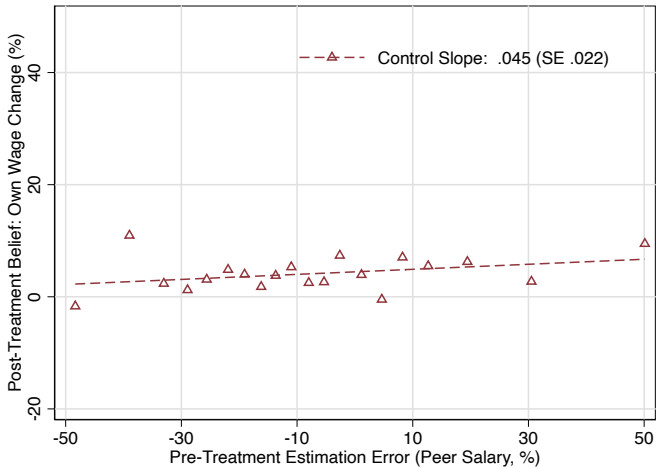


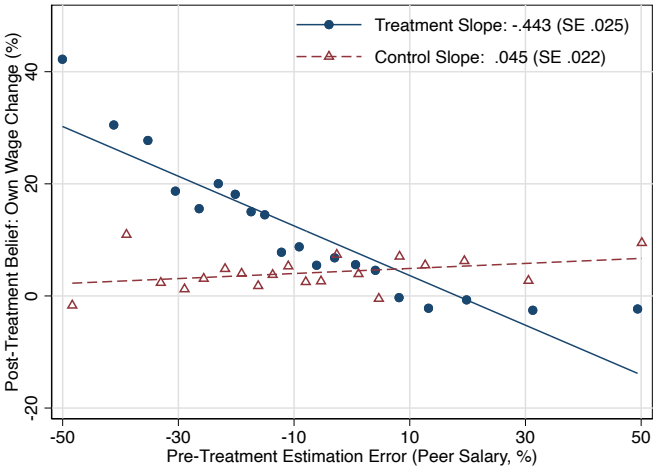
First Stage: Effects on Outside Option Beliefs



First Stage: Effects on Outside Option Beliefs



First Stage: Effects on Outside Option Beliefs



▸ GSOEP Info Treatment

First Stage

Information Experiment: Main Results

	(1) Post-Treat Estimation Error	(2) Post-Treat Beliefs: Own Wage Change	(3) Intended Quit Probability
Treated × Pre-Treat Estimation Error	-0.528***	-0.451***	
	(0.051)	(0.034)	
Treated	-1.644	4.199***	
	(1.222)	(0.732)	
Pre-Treat Estimation Error	0.902***	0.025	
	(0.037)	(0.022)	
Constant	4.120***	4.066***	
	(0.917)	(0.499)	
Mean Dep. Var.	-6.83	3.91	
Nb. obs	3206	3206	
IV: Belief: % Wage Change at OO			
Constant			
Control Group Mean			
First-Stage F-Stat			

IV: Effects on Intended Labor Market Behavior: Quit Probability

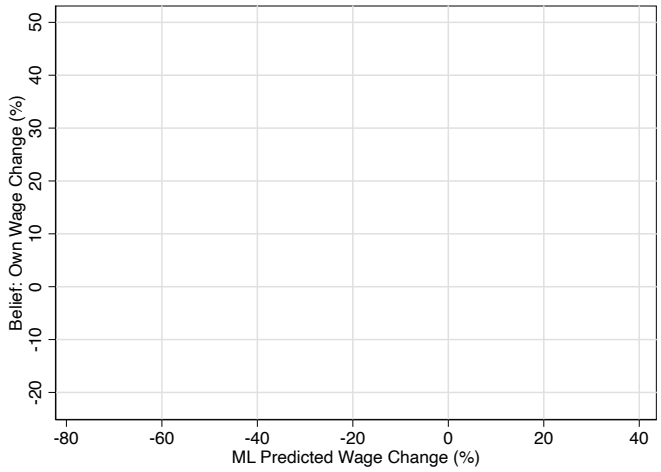
	(1) Post-Treat Estimation Error	(2) Post-Treat Beliefs: Own Wage Change	(3) Intended Quit Probability
Treated × Pre-Treat Estimation Error	-0.528***	-0.451***	-0.121***
	(0.051)	(0.034)	(0.043)
Treated	-1.644	4.199***	1.152
	(1.222)	(0.732)	(1.096)
Pre-Treat Estimation Error	0.902***	0.025	-0.036
	(0.037)	(0.022)	(0.032)
Constant	4.120***	4.066***	22.823***
	(0.917)	(0.499)	(0.776)
Mean Dep. Var.	-6.83	3.91	24.06
Nb. obs	3206	3206	3206
IV: Belief: % Wage Change at OO			0.269***
			(0.078)
Constant			21.739***
			(0.725)
Control Group Mean			23.055
First-Stage F-Stat			171.515

IV: Effects on Intended Labor Market Behavior

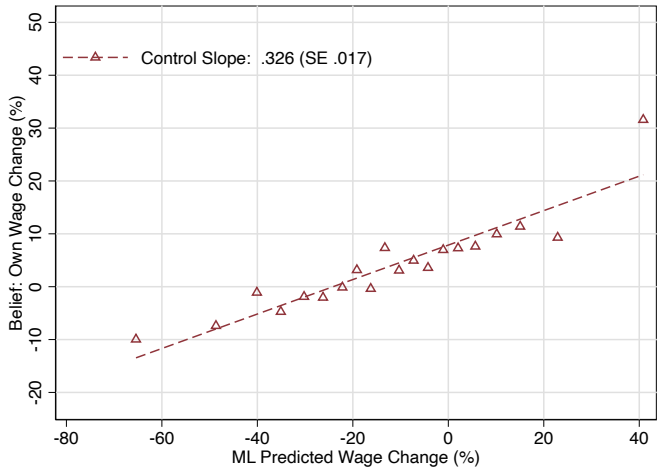
	(3) Intended Quit Probability	(4) Intended Search Probability	(5) Intended Negotiation Probability	(6) Intended Neg Magnitude (No Neg = 0)	(7) Reservation Wage Cut
Treated × Pre-Treat Estimation Error	-0.121***	-0.066	-0.187***	-0.029***	0.036
	(0.043)	(0.044)	(0.048)	(0.005)	(0.035)
Treated	1.152	2.499**	0.945	0.166	-2.718
	(1.096)	(1.115)	(1.295)	(0.132)	(2.014)
Pre-Treat Estimation Error	-0.036	-0.056*	0.088**	0.007*	-0.028
	(0.032)	(0.030)	(0.034)	(0.004)	(0.033)
Constant	22.823***	24.235***	39.134***	6.942***	11.621***
	(0.776)	(0.768)	(0.923)	(0.092)	(1.998)
Mean Dep. Var.	24.06	26.08	39.66	7.08	10.36
Nb. obs	3,206	3,206	3,206	3,206	3,204
IV: Belief: % Wage Change at OO	0.269***	0.223***	0.382***	0.059***	-0.176
	(0.078)	(0.079)	(0.092)	(0.010)	(0.167)
Constant	21.739***	24.083***	37.261***	6.659***	11.381***
	(0.725)	(0.734)	(0.856)	(0.090)	(1.557)
Control Group Mean	23.055	24.595	38.574	6.895	11.799
First-Stage F-Stat	171.515	171.515	171.515	171.515	170.520

▸ Over-Under Estimators

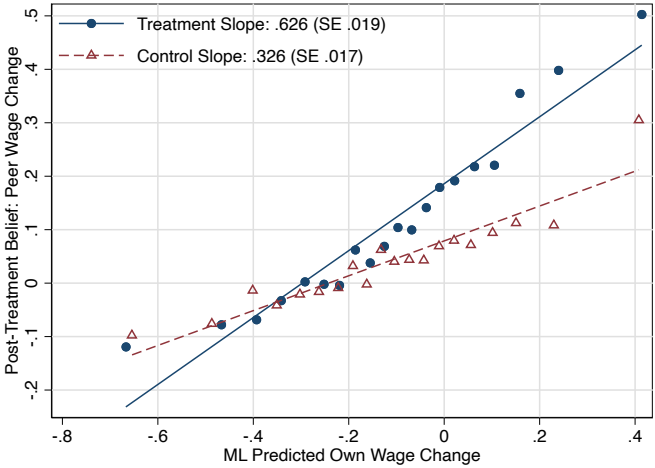
Post-Treatment: Personal Outside Option Beliefs vs ML Predictions



Post-Treatment: Personal Outside Option Beliefs vs ML Predictions



Post-Treatment: Personal Outside Option Beliefs vs ML Predictions



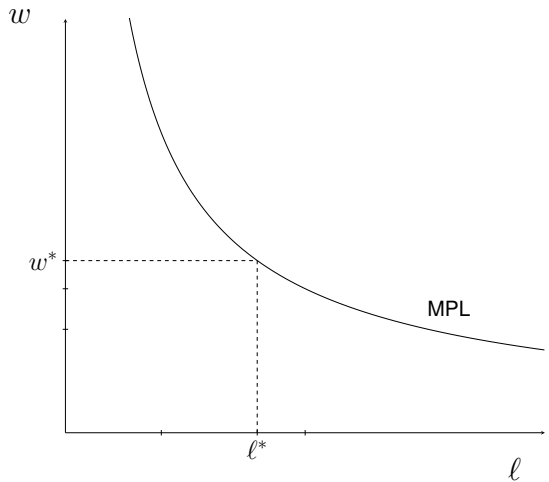
Equilibrium Consequences of Worker Misperceptions

- Old hypothesis (Robinson, 1933): Workers' misperceptions may generate employer monopsony, and may help sustain wage markdowns and wage dispersion
- Simple equilibrium model (adopt and extend product market framework of Salop and Stiglitz, 1977, to labor market and misperceptions (anchoring)):
  - Sophisticated and naive workers: experts and amateurs
  - Firms strategically set wages to maximize profits
- Largely graphical intuitions in slides; full paper has ▸ Full Model

Timing

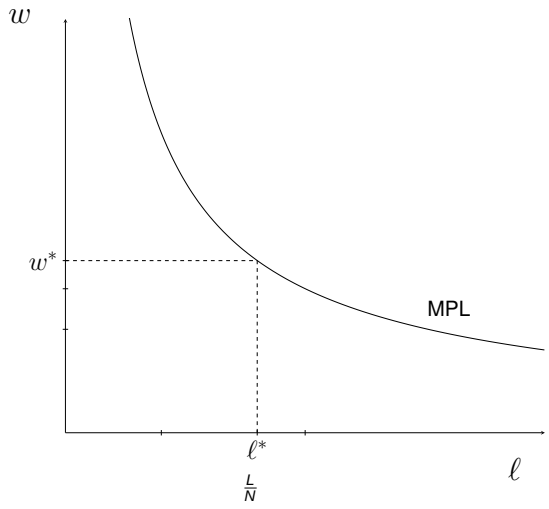
1. N firms enter labor market and post wage w
2. Randomly allocate L workers across N firms
3. Workers observe their firm's wage, choose whether to search (costly) and move to higher (highest) paying firm
   - Share a of **experts**: costless search and accurate beliefs
   - Share $(1-a)$ of **amateurs**: search costs c_A and anchored beliefs
4. Production and wage payments

Standard Competitive Equilibrium



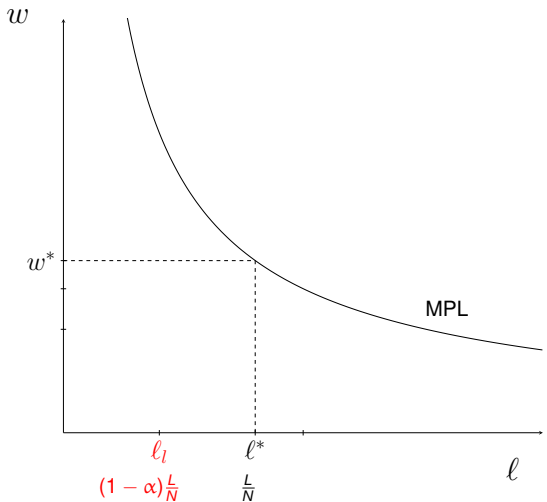
▸ Full Model

Competitive Firm Size



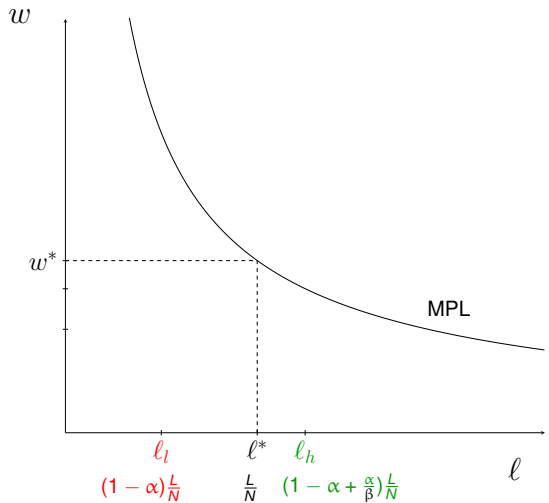
▸ Full Model

Low-Wage Firm Size



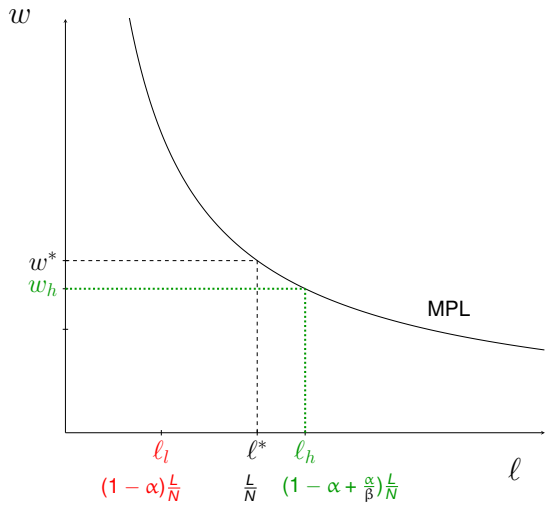
▸ Full Model

High-Wage Firm Size



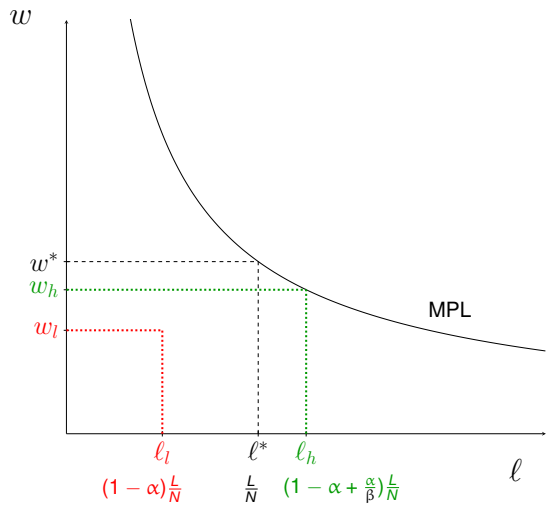
▸ Full Model

Wages in the High-Wage Sector



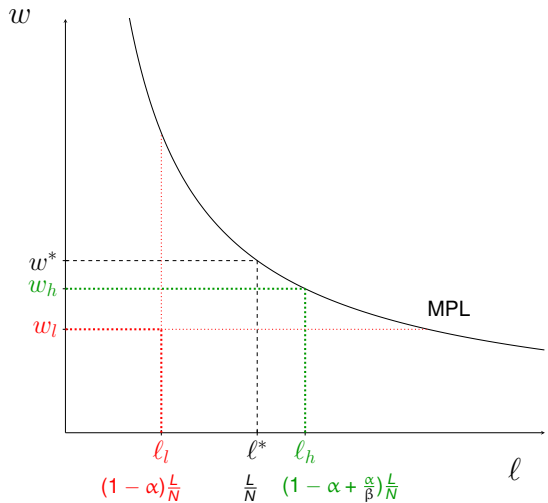
▸ Full Model

Wages in the Low-Wage Sector



▸ Full Model

Wage Markdowns in the Low-Wage Sector



▸ Full Model

Wage-Setting: Worker Beliefs and Reservation Wages

- Simple setup: amateurs' priors are weighted avg of current wage and true max wage:

$$\tilde{w}^{\max} = g \cdot w_j + (1-g) \cdot w^{\max} \tag{1}$$

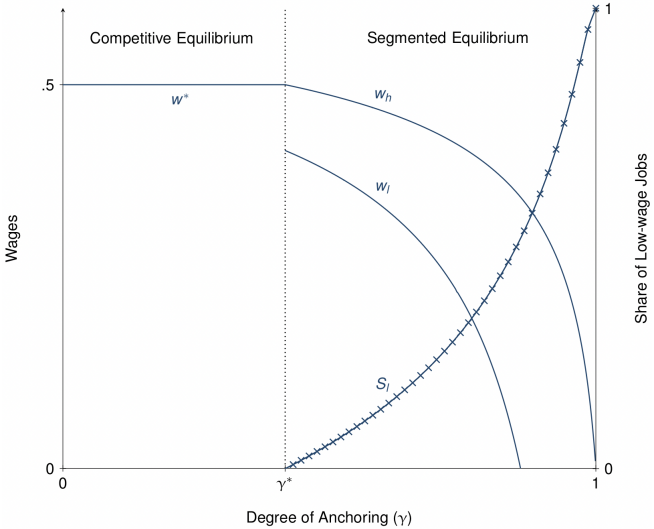
- $g \in [0,1]$ guides the degree of anchoring
- Since true max wage is the competitive wage w^*, optimal w' is:

$$w_l = w^* - \frac{c_A}{1-g} \tag{2}$$

- Higher search costs or stronger anchoring push down w_l

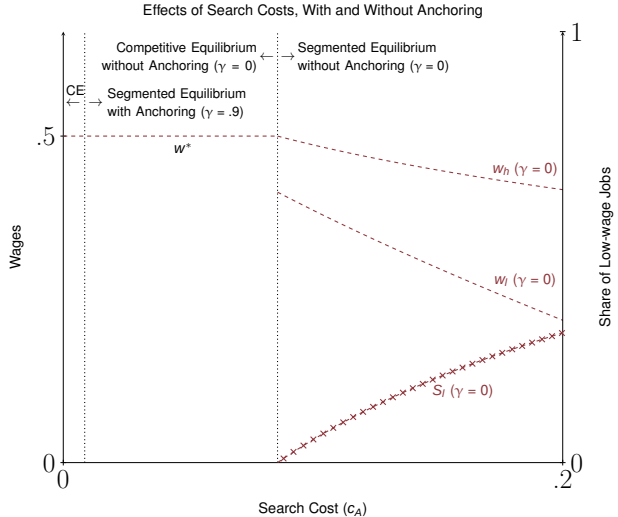
▸ Back

Effects of Anchoring on Equilibrium



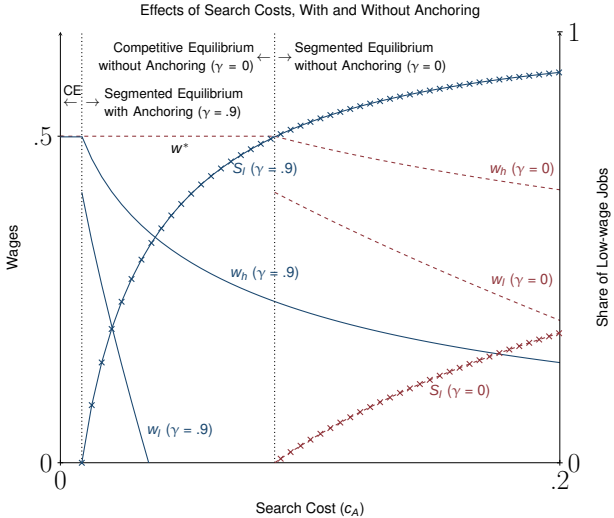
▸ Full Model

Effects of Search Costs on Equilibrium



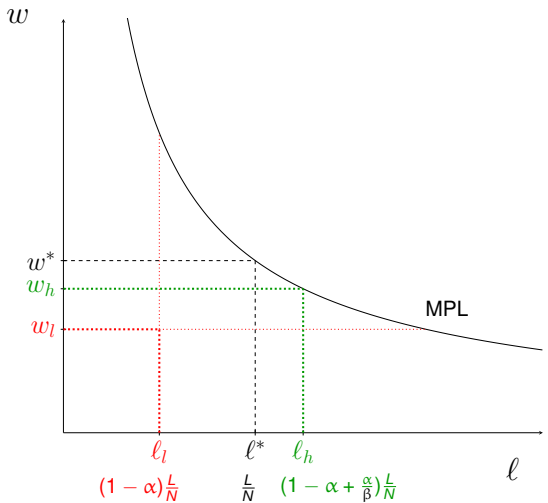
▸ Full Model

Effects of Search Costs on Equilibrium



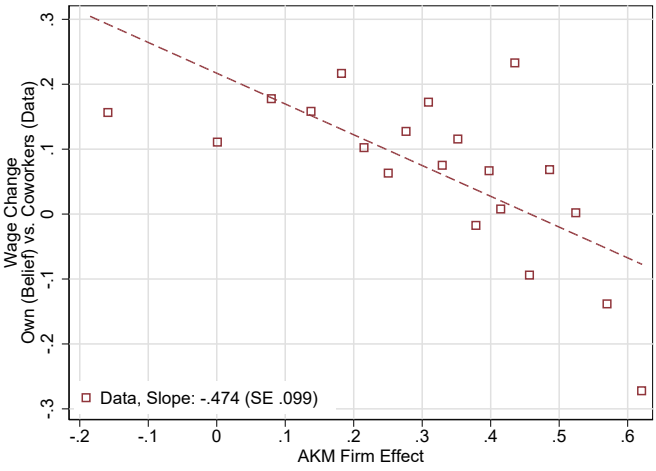
▸ Full Model

Key Feature and Prediction: Misinformed Workers in Low-Wage Firms



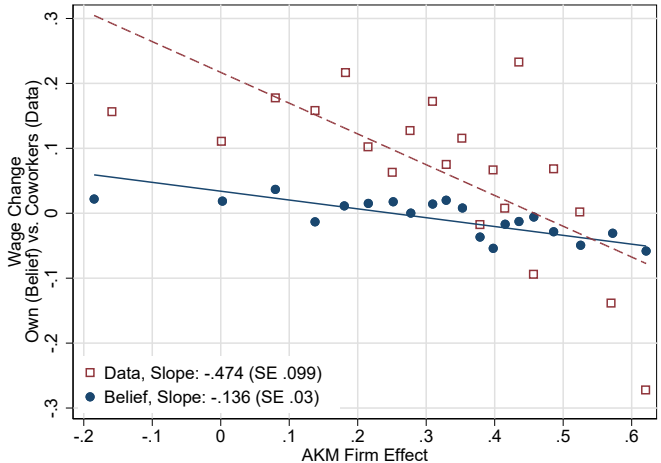
▸ Full Model

Beliefs vs Coworker Wage Changes by AKM Firm Effect



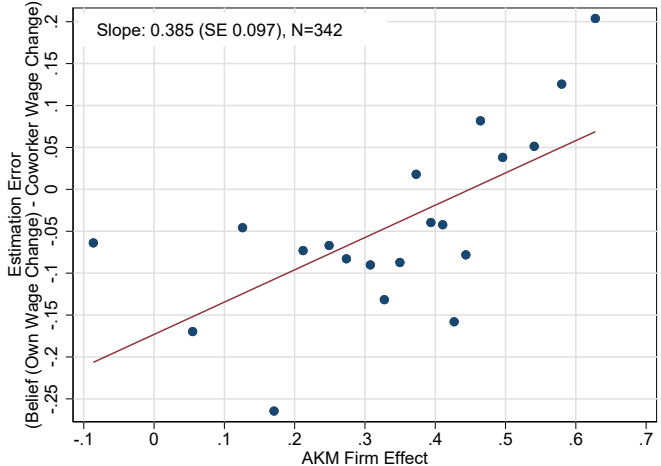
▸ Beliefs About Coworkers

Beliefs vs Coworker Wage Changes by AKM Firm Effect



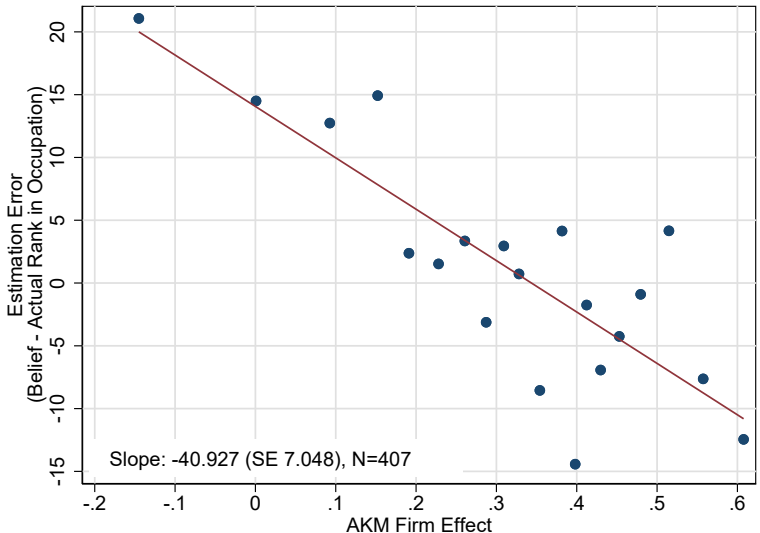
▸ Beliefs About Coworkers

Errors (Own Wage Change) by AKM Firm Effect

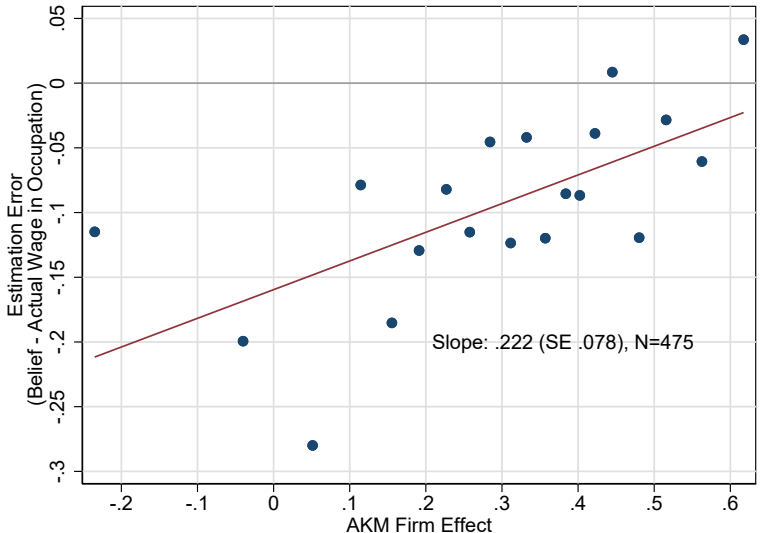


▸ Beliefs About Coworkers

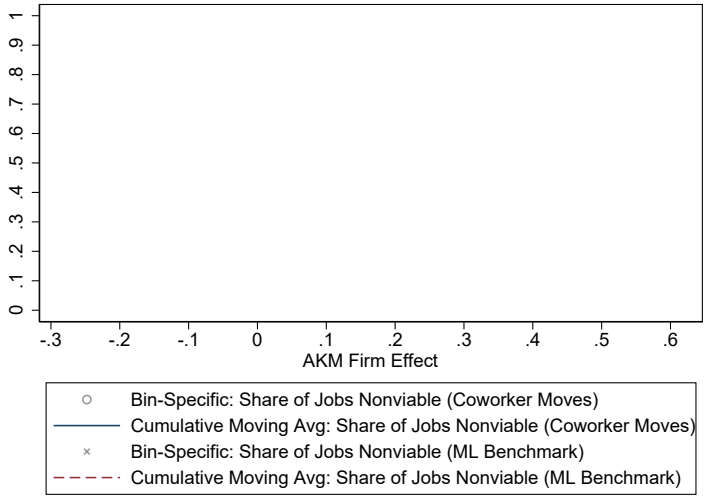
Errors (Rank in Occupation) by AKM Firm Effect



Errors (Median Salary in Occupation) by AKM Firm Effect

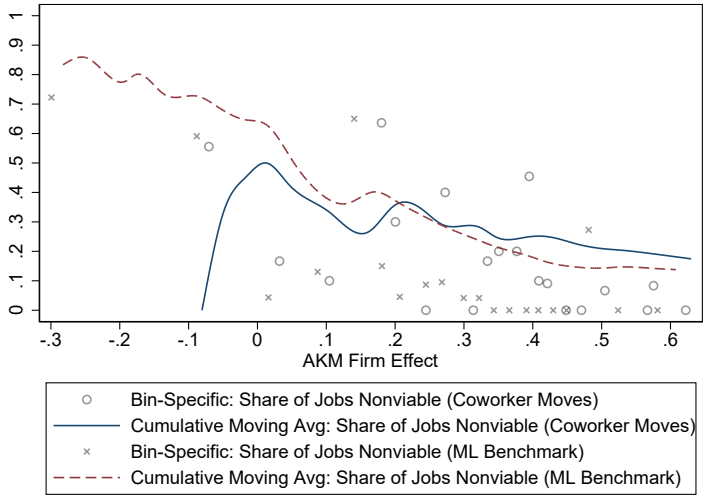


Share of Nonviable Jobs with Corrected Beliefs



Recalculate surplus: replace subjective wage component with coworker mover wage change (average in AKM ventile) or ML prediction for wage change, keep non-wage component fixed. Full Methodology

Share of Nonviable Jobs with Corrected Beliefs



Recalculate surplus: replace subjective wage component with coworker mover wage change (average in AKM ventile) or ML prediction for wage change, keep non-wage component fixed. Full Methodology

Conclusion

1. Do workers accurately perceive wage differences across firms?
   - No: workers underestimate wage differences across firms
   - Workers anchor beliefs about external labor market on current employer
2. How systematic are workers' biases about outside options with other employers?
   - Workers, especially at low-paying firms, underestimate their outside options.
   - Targeted wage information improves accuracy of workers' beliefs and leads them to shift their planned behavior
3. What are equilibrium consequences of misperception about outside options?
   - Monopsony and wage markdowns
   - Labor market segmentation with high- and low-wage sector

Worker Beliefs About Outside Options

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Christopher Roth
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Nina Roussille
LSE

Benjamin Schoefer
UC Berkeley

Columbia
October 2022

Our Paper: Main Results

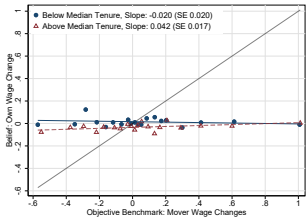
- Workers have systematic misperceptions about outside options
  - Workers mistakenly believe outside options are similar to current employment conditions (anchoring)
  - Workers, especially at low-paying firms, underestimate their outside options.
- Targeted wage information improves accuracy of workers' beliefs and leads them to shift their planned behavior
- Analyze equilibrium consequences of worker misperception in very simple labor market model

  Adopt and extend product market framework in Salop and Stiglitz (1977) to labor market and allow for misperceptions (anchoring)
  - Key insight: Misperceptions can be source of monopsony, wage markdowns, and labor market segmentation.

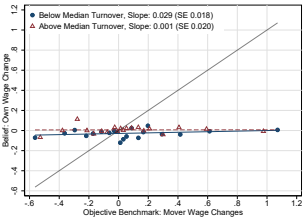
    Formalization of Robinson's (1933) insight
  - Evaluate model predictions in the data

Biased Beliefs Among All Subgroups

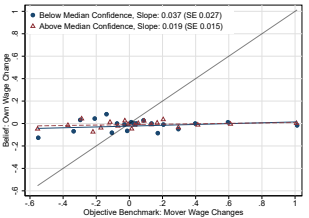
(a) Tenure



(b) Coworker Turnover



(b) Confidence



Split workers by whether above/below median of heterogeneity variable.

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Appendix

GSOEP-IS - Summary Statistics

	Mean	Median	Obs.
Age	43.93	44.00	1604
Years of Education	13.15	12.00	1517
Salary	40998	34800	1604
Tenure	10.85	7.00	1604
Female	0.47	0.00	1604
Full-time Employed	0.72	1.00	1604
Part-time Employed	0.28	0.00	1604

Back

GSOEP-IAB Matched Sample - Summary Statistics

	Mean	Median	Obs.
Age	43.89	45.00	516
Salary	37978	34710	516
Tenure	10.19	6.00	516
Female	0.50	1.00	516
Full-time Employed	0.70	1.00	516
Part-time Employed	0.30	0.00	516

Main Specification in GSOEP

	(1) Post-Treat: Beliefs Own Wage Change	(2) Intended Search Probability	(3) Intended Negotiation Probability	(4) Intended Neg Magnitude (No Neg = 0)	(5) Intended Neg Magnitude (No Neg = Msg)	(6) Reservation Wage Cut
Treated × Estimation Error	-0.028*	0.017	0.003	0.006	0.001	0.001
	(0.017)	(0.025)	(0.035)	(0.018)	(0.002)	(0.002)
Treated	0.528	1.486	-1.749	-1.095	0.023	-0.001
	(0.750)	(1.857)	(2.326)	(0.759)	(0.093)	(0.091)
Estimation Error	0.023	-0.033	-0.012	-0.006	-0.000	-0.000
	(0.016)	(0.024)	(0.033)	(0.018)	(0.002)	(0.002)
Constant	-1.126**	15.070***	22.970***	14.968***	3.336***	3.403***
	(0.558)	(1.293)	(1.740)	(0.554)	(0.067)	(0.065)
Nb. obs	1,186	1,181	1,182	1,186	1,186	1,167

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

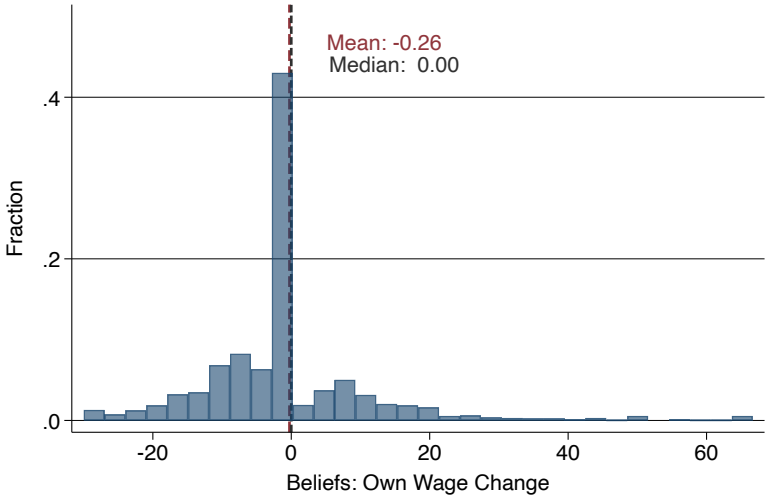
▸ Back to GSOEP

Expert Survey - Summary Statistics

	Mean	Median	SD	Min	Max	Obs.
Share of Respondents: Female	21.85					151
Share of Respondents: Professor	47.02					151
Share of Respondents: Associate Professor	17.22					151
Share of Respondents: Assistant Professor / Lecturer	24.50					151
Share of Respondents: US based	61.59					151
Share of Respondents: Germany based	16.56					151
Share of Respondents: UK based	9.27					151
Age	42.82	40	9.59	27	80	149
h – index	22.12	21.92	22.32	0	118	151

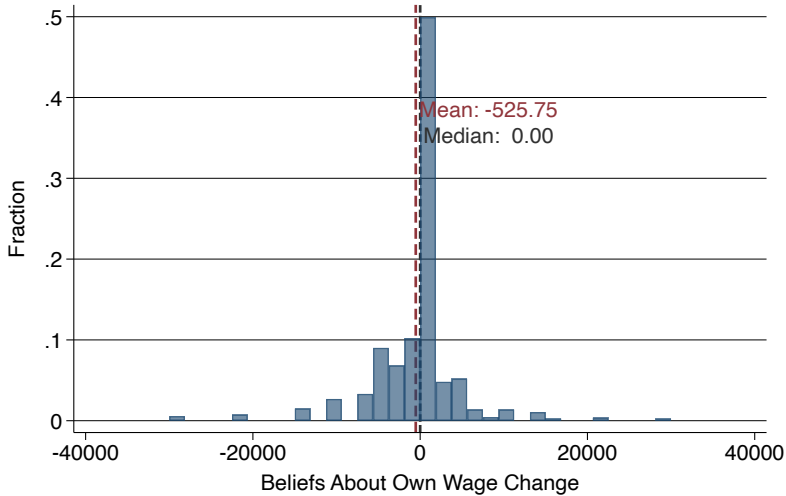
Back

Beliefs About Own Wage Change (Percent)

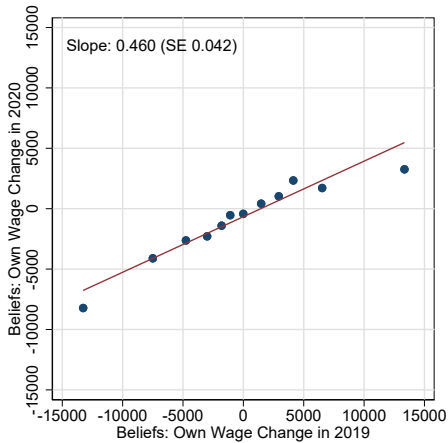


Back

Beliefs About Own Wage Change (Euros)



Persistence of Beliefs (Euros)



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Robustness

In July 2021 we fielded a **robustness survey** which demonstrates robustness of beliefs to:

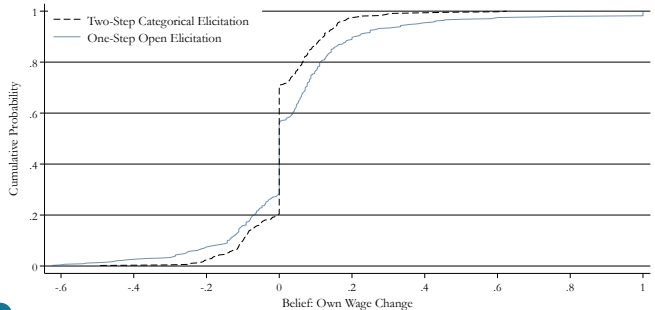
- **Elicitation format** (change vs. level elicitation) ▸ Figure
- Conditioning on **staying in the same occupation** ▸ Figure
- Different **time horizons** of search (3 months vs 12 months) ▸ Figure
- Different **framing** of reason for separation (general framing vs. layoff) ▸ Figure
- **Prediction incentives** for beliefs about median wage in own occupation ▸ Figure
- **Elicitation of min pay raise** at another firm to quit, rather than pay cut at current firm ▸ Figure

In May 2021, conducted a survey with **German HR managers** to shed light on the firm-sides ▸ Details ▸ Back

Robustness to Elicitation Format I: Change vs Levels

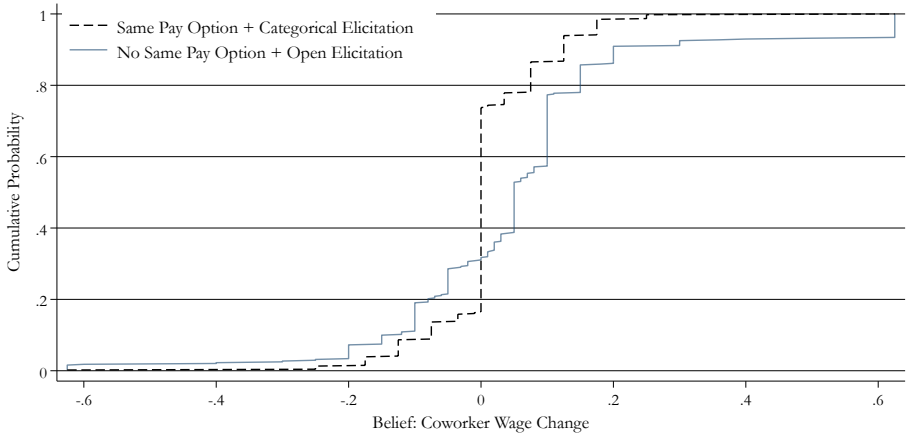
Wording in brackets are randomized to 50% of respondents:

Imagine you are forced to leave your current job and had [3 / 12 months] to find a job with another employer [in the same occupation].
In the job with another employer, how much would you receive per month as gross employment income in Euro? ___ Euro
[Reminder: Your current gross monthly income is ___ Euro.]
How confident are you in your previous estimate? (very certain, certain, uncertain, very uncertain)



▸ Back to question in main slides

Robustness to Elicitation Format II: No "Same Pay" Option

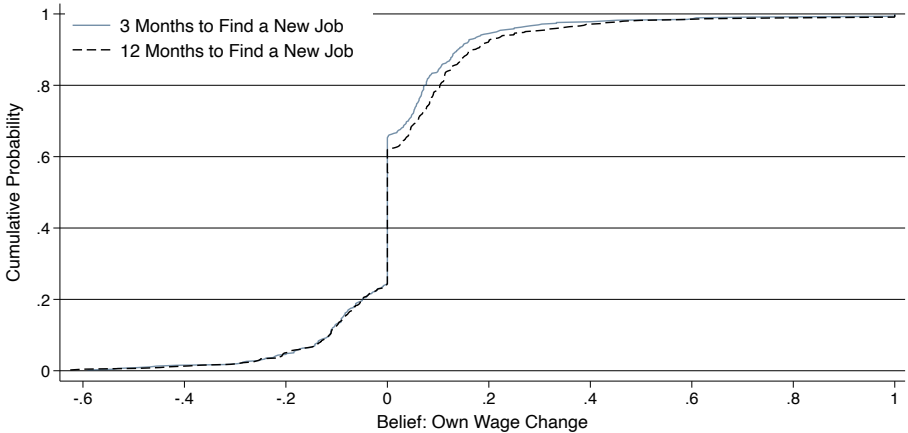


Back

Robustness to Occupation-Specific Search

Back to question in main slides

Robustness to Time Horizon of Search



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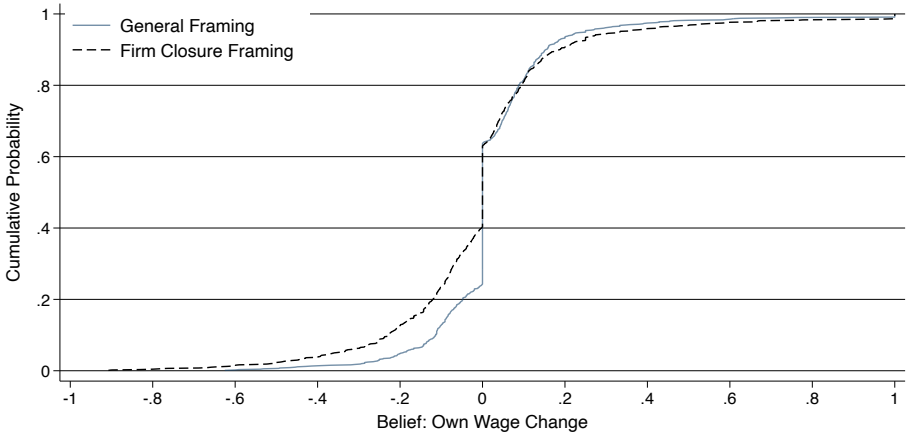
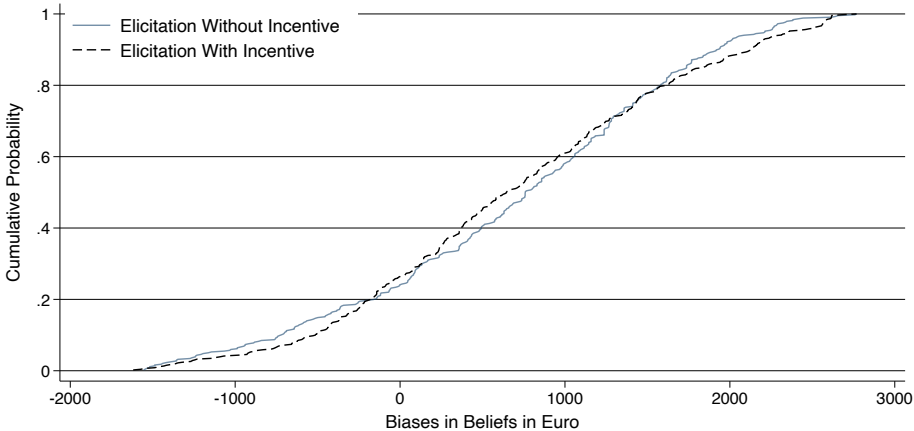
Robustness to Framing of Reason for Separation



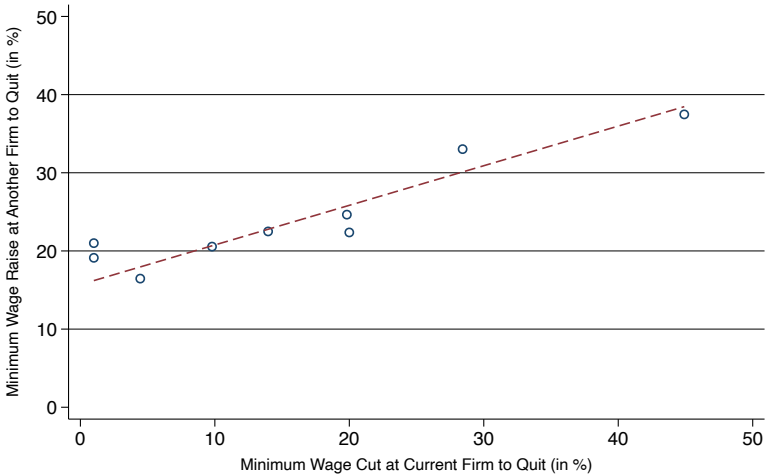
Back to question in main slides

Robustness to Prediction Incentives



Back to question in main slides

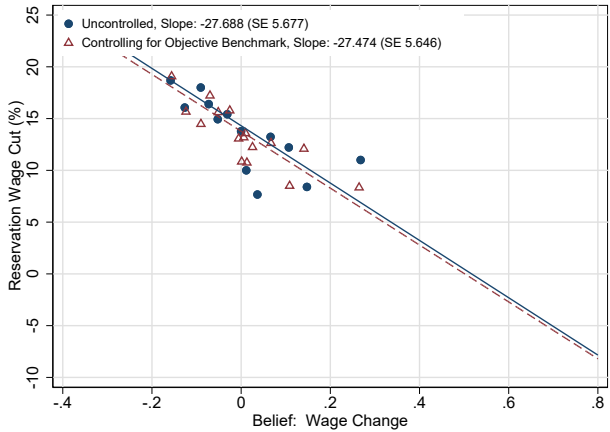
Robustness to Reservation Wage Elicitation: Cut vs Raise



Slope: .507 (SE .059), N=1,537

Back to question in main slides

Beliefs Predict Reservation Wage Cuts



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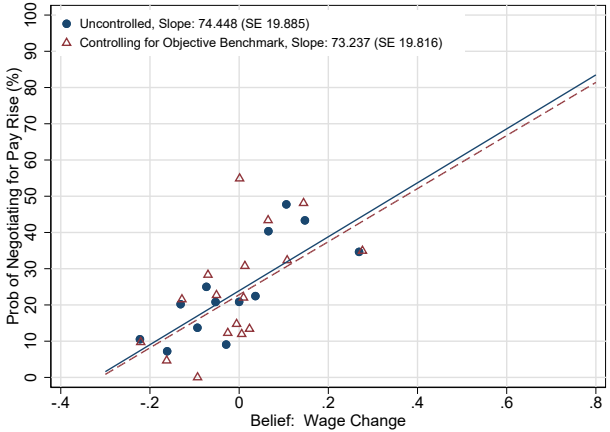
Beliefs Predict Intentions to Bargain



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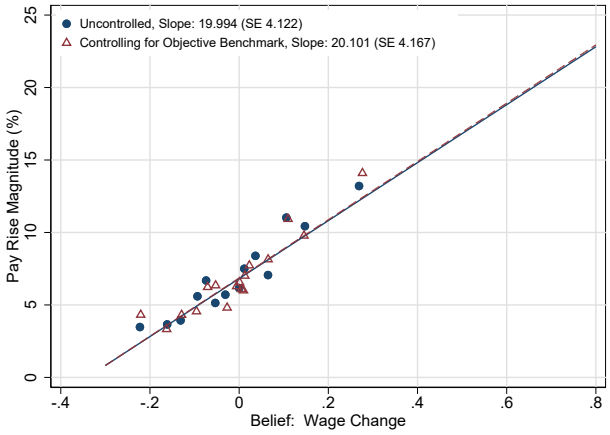
Beliefs Predict Intended Magnitude of Negotiation



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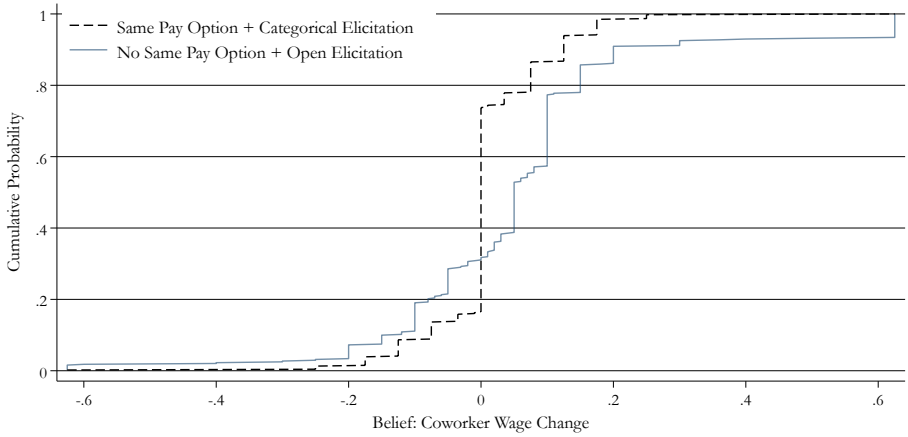
Robustness: No "Same Pay" Option



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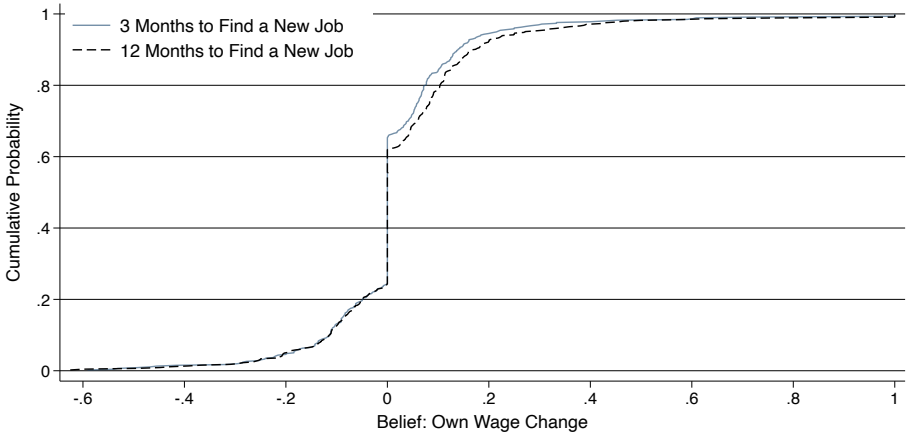
Robustness: Don’t Condition on Staying in Occupation

Back

Robustness: Vary Time Horizon of Search



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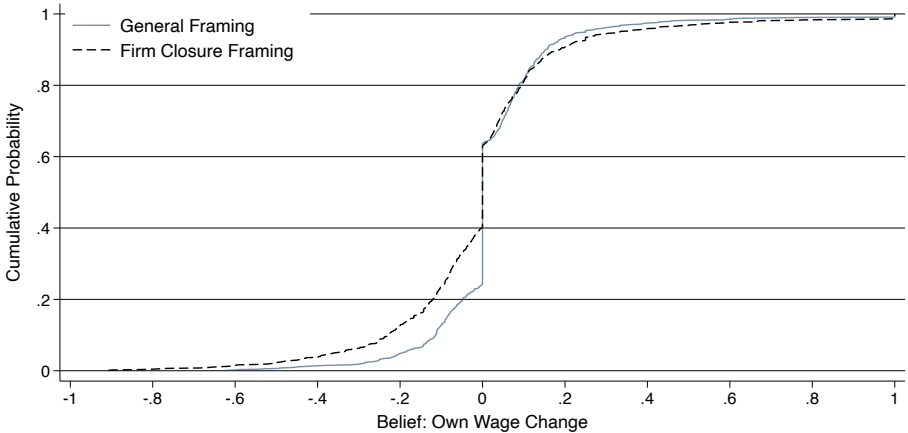
Robustness: Vary Reason for Separation



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Bayesian Model with Normal Learning

- N firms
- Worker's prior beliefs about wages are given by

$$w_j|q \sim N(q, 1/p) \quad \forall j \tag{3}$$
$$q \sim N(m, 1/t). \tag{4}$$

- Worker employed at firm j observes the wage w_j and updates her beliefs about q according to Bayes rule:

$$q|w_j \sim N\left(\frac{w_j p + m t}{p + t}, p + t\right), \tag{5}$$

$\Rightarrow$ Posterior belief about q will be increasing in the current wage w_j (as long as some uncertainty over q and finite variance of wages)

▸ Proof ▸ Back to Research Design ▸ Back to Results Summary

Formation of Worker's Posterior About Wages at Other firms

We use Bayes' Rule to write the employed worker's joint posterior:

$$f(w_k, q|w_j) = \frac{f(w_j|w_k, q)\, f(w_k|q)\, f(q)}{f(w_j)} \tag{6}$$

$$= \frac{f(w_j|q)\, f(w_k|q)\, f(q)}{f(w_j)} \qquad |\text{by cond. ind.} \tag{7}$$

The marginal posterior for q is given by integrating over the wage w_k:

$$f(q|w_j) \propto \int f(w_j|q)\, f(w_k|q)\, f(q)\, dw_k \qquad |\int f(w_k|q)\, dw_k = 1 \tag{8}$$

$$= f(w_j|q)\, f(q) \tag{9}$$

$$= f(q; w_j, p)\, f(q; m, t) \qquad |\text{by sym. of Normal distr.} \tag{10}$$

Utilizing product characteristics of normal distributions, gives:

$$q|w_j \sim N\left(\frac{w_j p + m t}{p + t}, p + t\right) \tag{11}$$

▸ Back to start of Bayesian model

Empirical Bayes Methodology[1]

- Firm j's mean coworker wage change $\widehat{\mathsf{D}}_j$ is the firm's "true" leaver wage change parameter D_j plus random error:

$$\widehat{\mathsf{D}}_j = \mathsf{D}_j + e_j \tag{12}$$

$$\widehat{\mathsf{D}}_j | \mathsf{D}_j, s_j^2 \sim N(\mathsf{D}_j, s_j^2) \tag{13}$$

- Suppose we know underlying distribution of leaver wage change parameters:

$$\mathsf{D}_j \sim N(\bar{\mathsf{D}}, s^2) \tag{14}$$

- Idea: shrink D_j towards $\bar{\mathsf{D}}$ to reduce influence of e_j on regression results

Back to EB Graph | Back to Full Main Exhibit

[1]Reference: Chandra, Finkelstein, Sacarny, and Syverson (2016), "ebayes.ado" by Adam Sacarny

Empirical Bayes Methodology[2]

- Posterior distribution of D_j given observed mean $\widehat{D}_j$ and population parameters $\bar{D}, s^2$ is:

$$D_j|\widehat{D}_j, \bar{D}, s^2 \sim N(D_j^{EB}, s_j^2(1-b_j)) \tag{15}$$

where:

$$b_j = s_j^2/(s_j^2 + s^2) \tag{16}$$

$$D_j^{EB} = (1-b_j)\widehat{D}_j + b_j\bar{D} \tag{17}$$

- D_j^{EB} is the posterior expected value of D_j, and is a weighted average of the observed mean and true population mean, weighted by relative variances of observed mean and population distribution

▸ Back to EB Graph ▸ Back to Full Main Exhibit

[2]Reference: Chandra, Finkelstein, Sacarny, and Syverson (2016), "ebayes.ado" by Adam Sacarny

Empirical Bayes Methodology[3]

- How to estimate D_j^{EB}?
- Estimate s_j^2 using within-firm variance of mover wage changes (requires restricting to firms with ≥ 2 movers)
- Estimate $\bar{D}$ and s^2 using an iterative procedure on population distribution of $\hat{D}$
- Details in Appendix C of Chandra, Finkelstein, Sacarny, and Syverson (2016)

▸ Back to EB Graph ▸ Back to Full Main Exhibit

[3]Reference: Chandra, Finkelstein, Sacarny, and Syverson (2016), "ebayes.ado" by Adam Sacarny

Lasso Methodology I

- Take universe of transitions between main employment spells, involving an intermediate unemployment spell, in Germany between 2015 and 2019 (excluding GSOEP respondents)
- Lasso regression
  - Dependent variable: log wage change associated with transition
  - Independent variables: worker and origin-firm covariates
- Use selected variables and estimated coefficients to generate predicted wage changes for GSOEP respondents

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Lasso Methodology II

Included covariates, in descending order of partial R-squared values:

- Wage at initial firm
- Age $\times$ education dummies
- Occupation (1-digit) at initial firm
- Industry $\times$ region dummies
- Gender
- Initial firm's AKM effect
- Age, tenure, education, and firm size, turnover, employment growth, wage dispersion, region, industry

No covariates end up excluded

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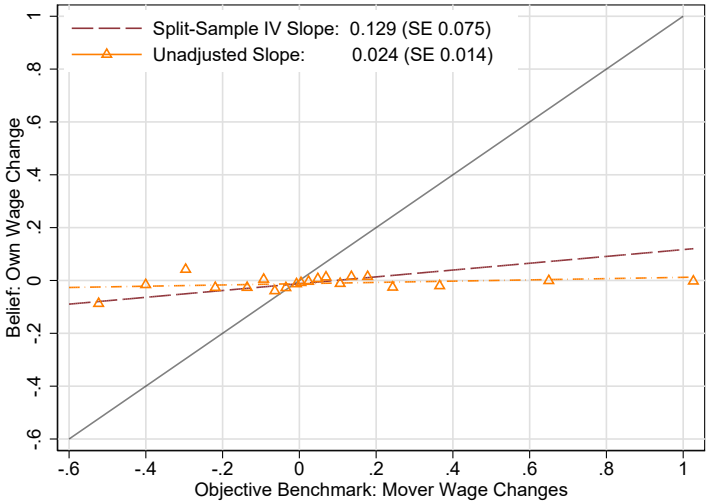
Coworker Moves: Split-Sample First-Stage

Back to Main Exhibit | Back to Beliefs About Coworkers

Subjective Outside Options: Median Coworker Wage Change



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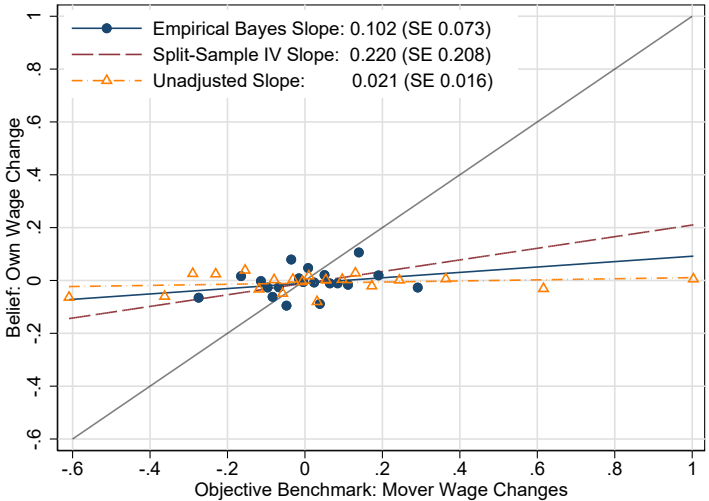
Subjective Outside Options: Different Time Horizon (2017-2019)



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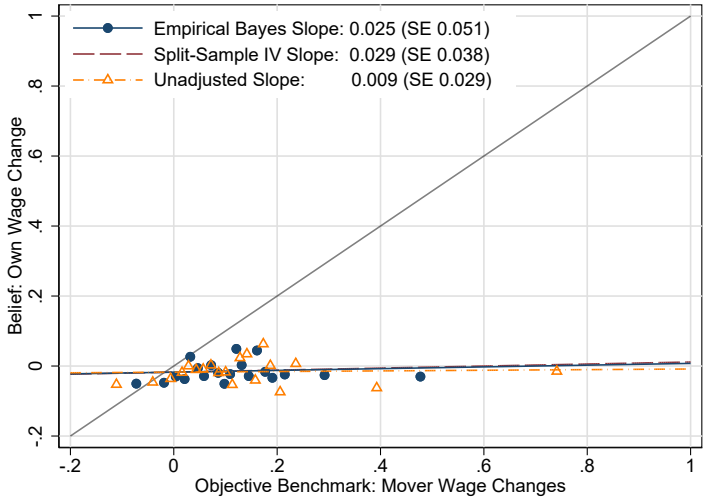
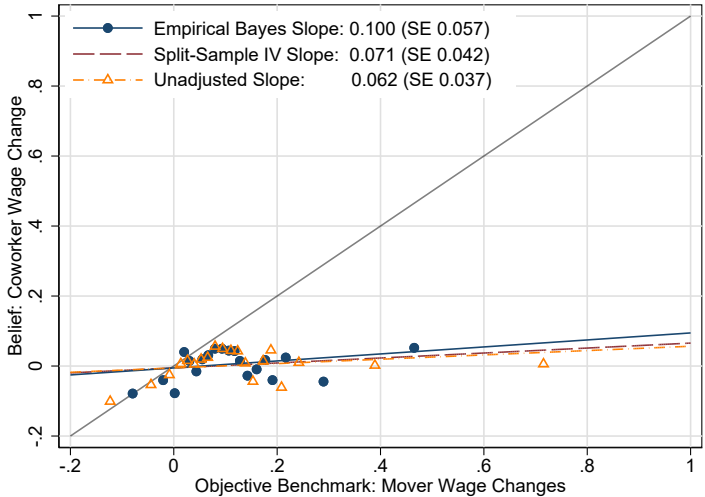
20+ Coworker Moves (Own Wage Change)



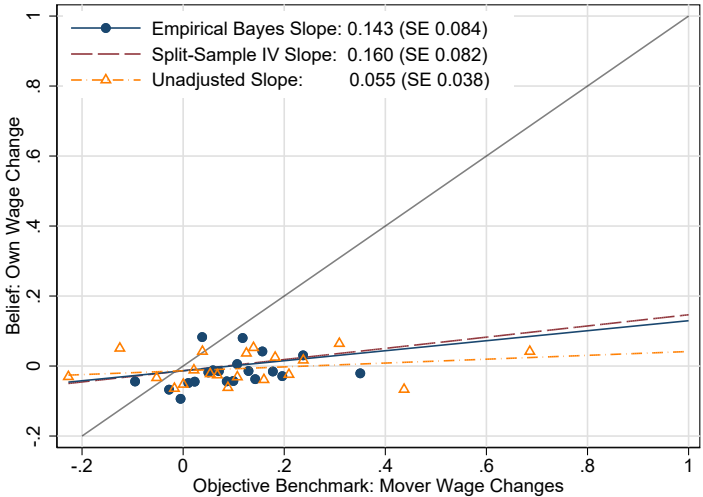
Back to Main Exhibit | Back to Alternative Set of Coworkers

20+ Coworker Moves (Coworker Wage Change)



Back to Mover Beliefs

Excluding "Same Wage" Responses (Own Wage Change)



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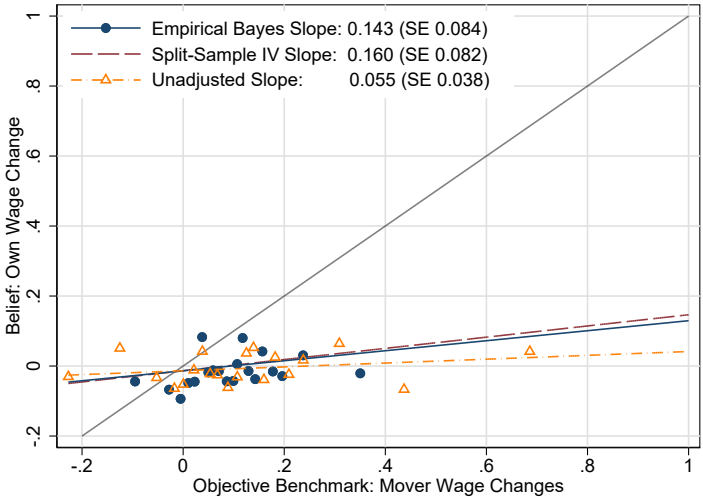
Excluding "Same Wage" Responses (Own Wage Change)



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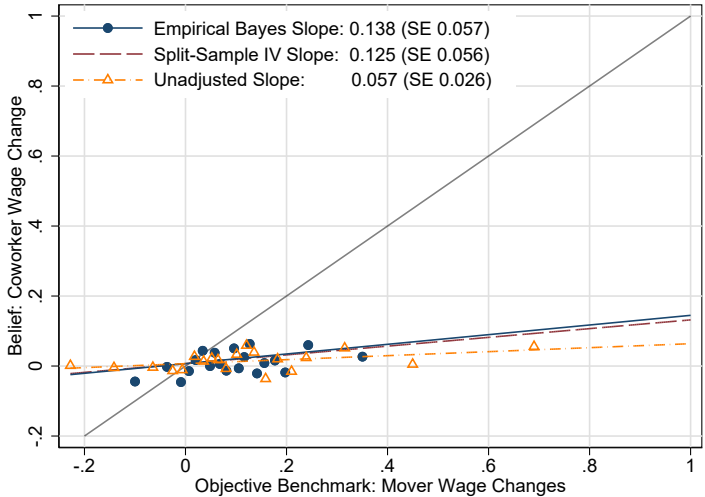
Excluding "Same Wage" Responses (Mover Wage Change)



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Own Wage Change Question

Imagine that you were forced to leave your current job and that you had 3 months to find a job at another employer in the same occupation. Do you think that you would find a job that would offer you a higher overall pay, the same pay or a lower pay?

- Higher pay
- Same pay
- Lower pay

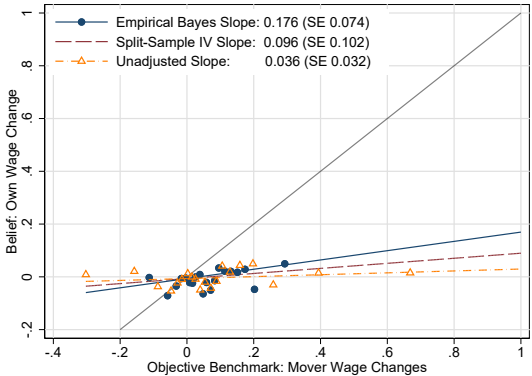
[Asked only if previous answer is not "Same pay"] What do you think: how much more/less would you earn in that new job?

- Between 0 and 50 Euros
- Between 50 and 100 Euros
- Between 100 and 200 Euros
- ...
- Between 2000 and 3000 Euros
- More than 3000 Euros

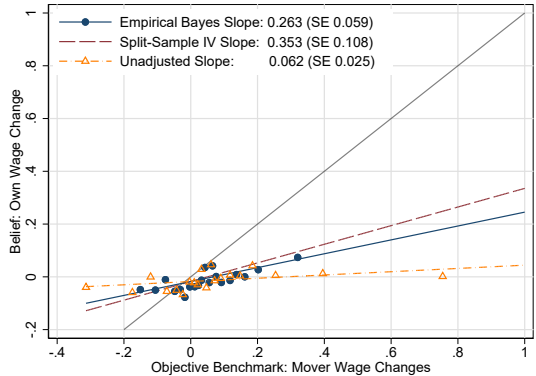
Back

Alternative Set of Coworkers II

(a) Same Age

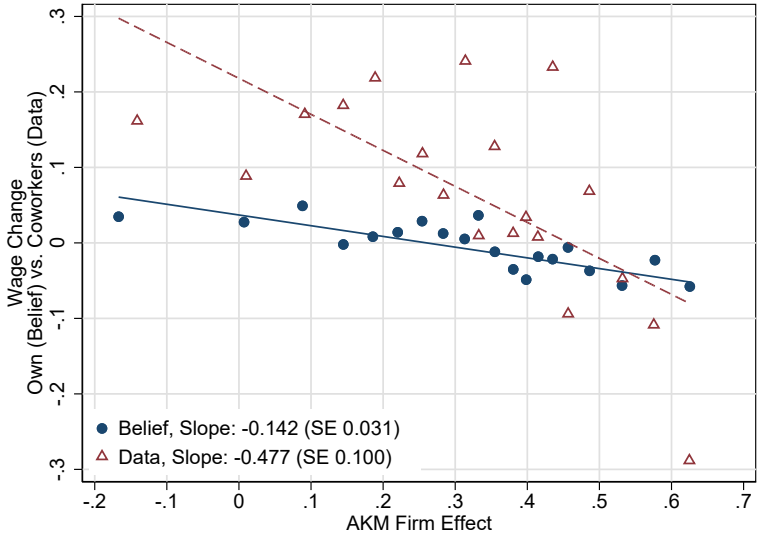


(b) Same Income



Back

Involunt. Move Wage Changes By AKM Firm Effect (Beliefs and Data)



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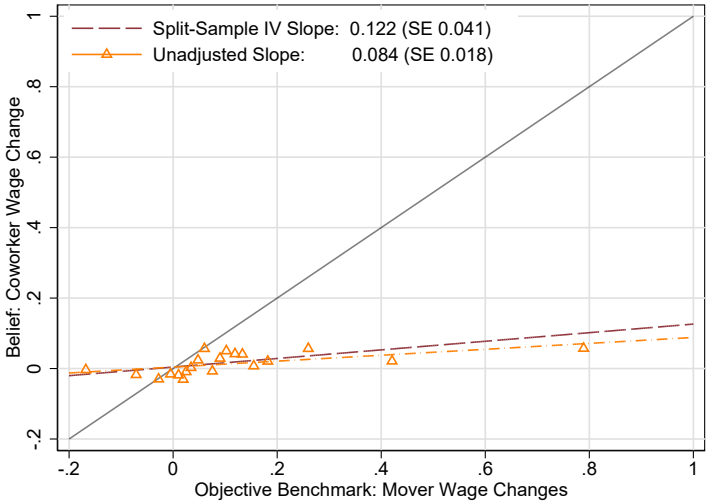
Beliefs About Coworkers: Median Coworker Wage Change



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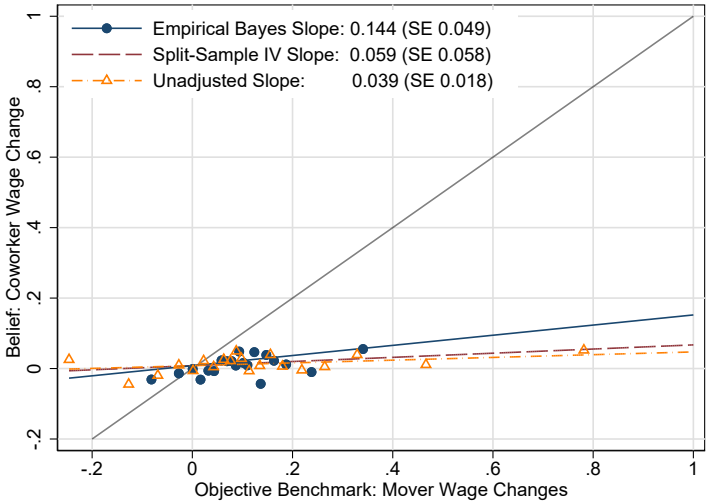
Beliefs About Coworkers: Different Time Horizon (2017-2019)



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Own Wage Rank Question

Think of all employees in Germany that work in the same occupation as you, but work at a different employer. What do you think: what percent of those employees receive a...

- Lower pay _ %
- Same pay _ %
- Higher pay _ %

(Please note: these numbers need to add up to 100%)

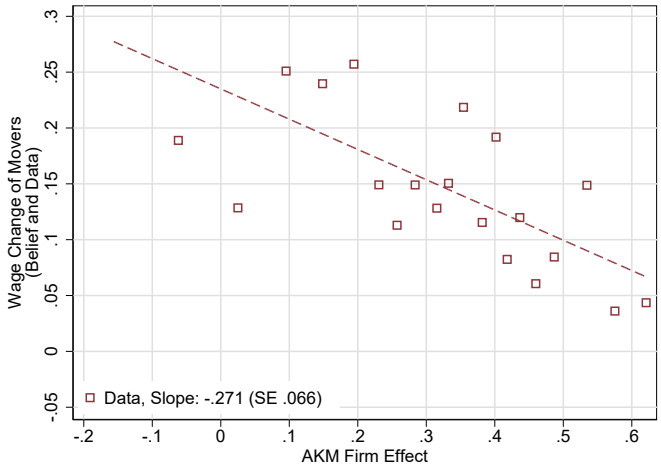
Back

Median Salary Question

- Think of all employees in Germany that are full-time employed and work in the same occupation as you. What do you think is the typical monthly pay of those employees before taxes (in Euro)?
- Here, we refer to the "typical" monthly earnings as the median monthly earnings, i.e. the earnings that the average full-time employee earns in their job, so that half of the full-time employees earn more in their job and the other half less than this earnings in the occupation according to the 2010 occupation classification.

Back

Beliefs vs Actual Coworker Wage Changes by AKM Firm Effect



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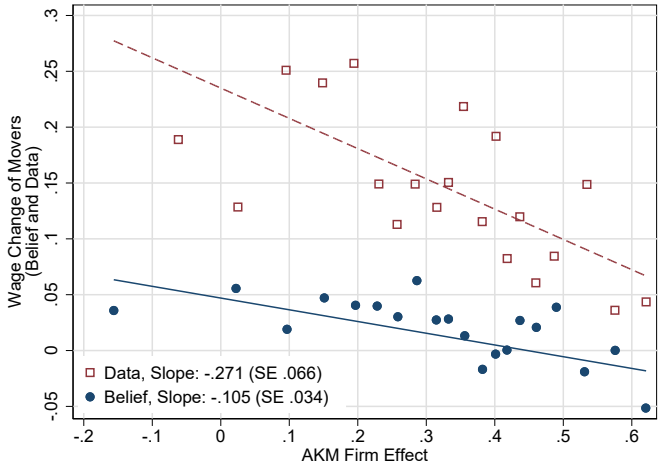
Beliefs vs Actual Coworker Wage Changes by AKM Firm Effect



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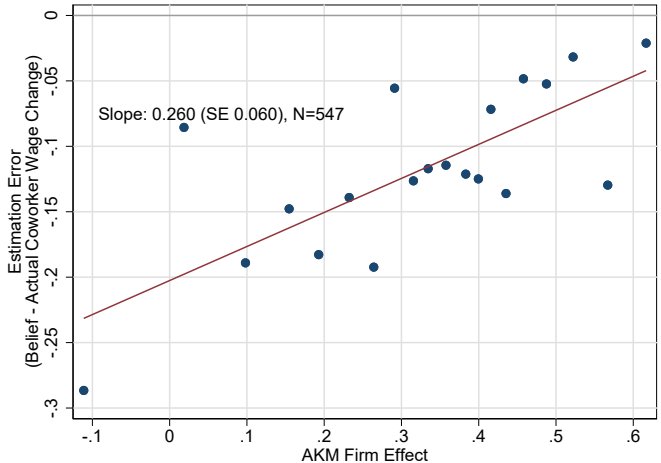
Errors (Coworker Wage Change) by AKM Firm Effect



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Survey Measure of Worker Surplus

- Definition: the worker surplus is the percent wage cut that makes the worker indifferent between her current firm and her second best option

- Measure Worker Rent c_i^* as follows:

  Imagine that your current employer were to permanently cut wages. This wage cut results from a change of the CEO in the company and is independent of the economic conditions in your industry. At which wage cut would you quit your job within one year?

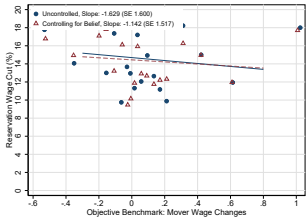
  I would quit my job if my current employer cut wages by more than c_i^*.

Cf. Mui and Schoefer (2021) reservation wage change to/from nonemployment

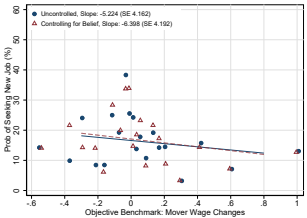
▸ Back

Intentions on Mover Wage Changes

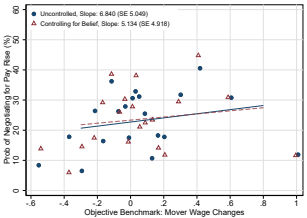
(a) Reservation Wage Cut



(b) Search for New Job

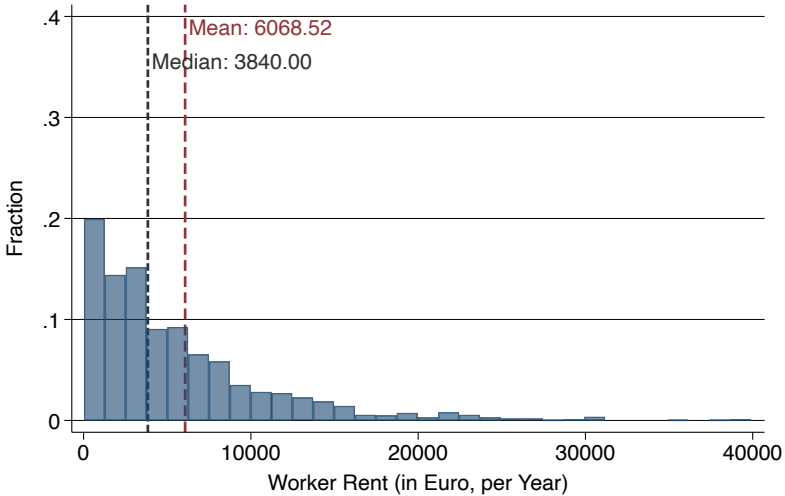


(b) Negotiate for Higher Pay



▸ Back

Worker Surplus (Euros)



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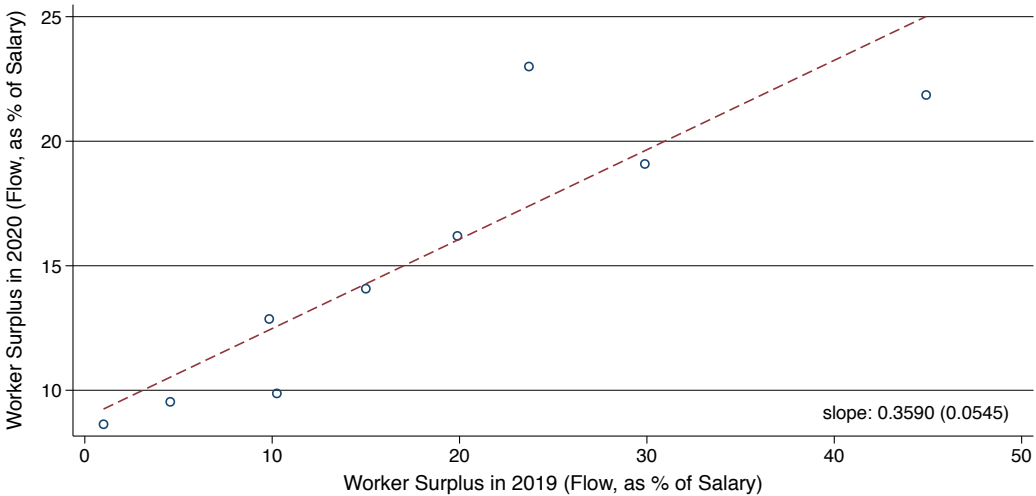
Persistence of Worker Surplus



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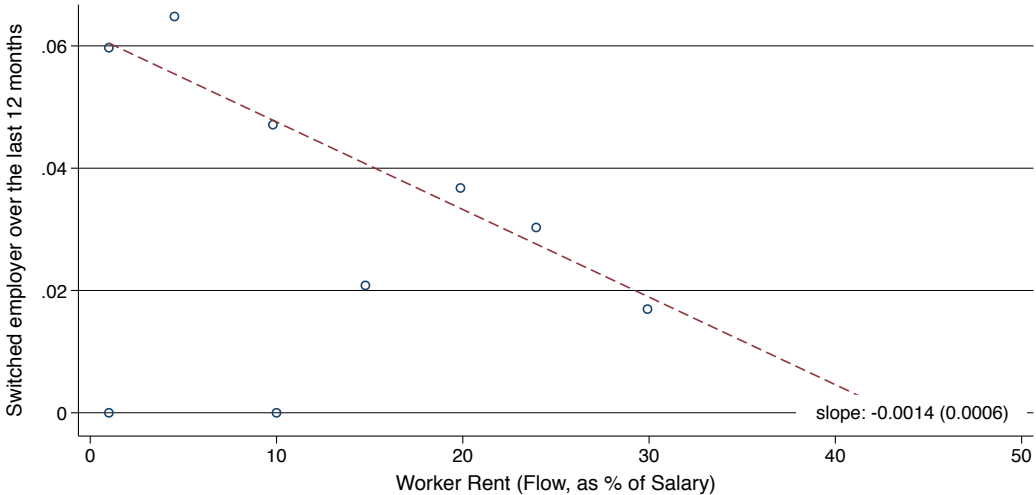
Worker Surplus Predict Lower Actual Separations



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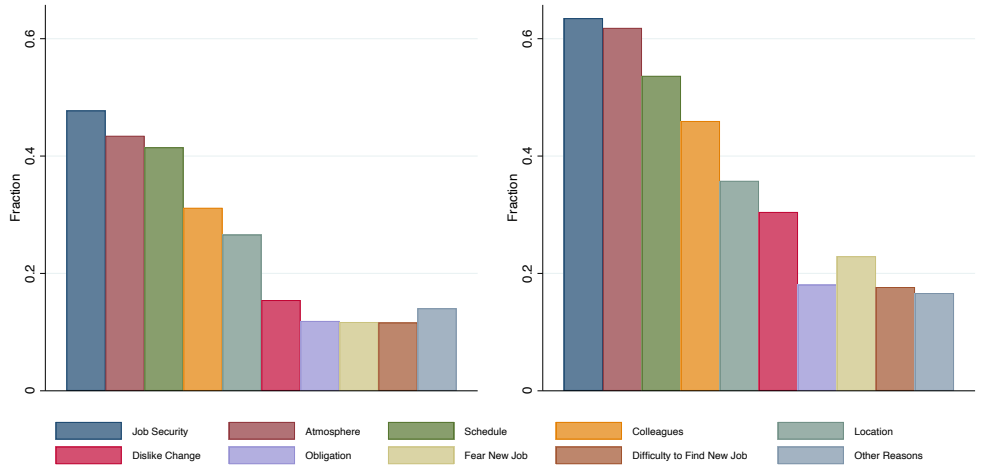
Reasons for Not Switching Employers



Coworker Wage Change Question

Think of the typical employee with work experience that switches from your current employer to another employer. Would this employee receive a lower, higher or the same pay compared to his previous employer?

- Higher pay
- Same pay
- Lower pay

[Asked only if previous answer is not "Same pay"] How much lower/higher would the monthly pay before taxes of this employee be (in percent) after the switch compared to his/her prior employer?

- Between 0% and 2%
- Between 2% and 5%
- Between 5% and 10%
- ...
- Between 50% and 75%
- More than 75%

Back

Setting

- N firms, each initially endowed with $\frac{L}{N}$ workers
- Produce a homogeneous good with DRS production function:

$$f(\ell) = \ell^h \qquad (h \in (0,1])$$

- Normal competitive equilibrium:
  - Wages equal MPL

$$w^* = h(\frac{L}{N})^{h-1} \tag{18}$$

  - Firms earn positive profits (no free entry)

Back

Timing

1. Firms enter labor market endowed with their workers, post a wage
2. Workers learn their firm's wage, choose whether to search (costly) and move to higher (highest) paying firm
   - Share a of **experts**: costless search and accurate beliefs
   - Share $(1-a)$ of **amateurs**: search costs c_A and anchored prior beliefs
3. Production occurs

Back

Wage-Setting: Temptation to Deviate?

- Suppose a competitive equilibrium.
- A firm has two options:
  - Pay competitive wage w^*, retain all workers, earn profits:

$$p_j = (\frac{L}{N})^h - w^* \frac{L}{N} \tag{19}$$

  - Deviate: pay lower wage $w' < w^*$, retain only amateurs, earn profits:

$$p_j = ((1-a)\frac{L}{N})^h - w'(1-a)\frac{L}{N} \tag{20}$$

- Tradeoff: paying lower wage leads to
  - $p \uparrow$ due to reduced wages ($w' < w^*$)
  - $p \downarrow$ due to reduced scale ($1-a$)

Back

Wage-Setting: Reservation Wages

- What is the optimal choice of lower wage w', conditional on deviating from competitive wage?
- Optimal w' is the lowest wage that still retains amateur workers
- Amateurs search (and hence leave) if perceived benefits of search exceed costs:

$$\widetilde{w}^{\max}(w_j, \mathbf{w}_{-j}) - w_j > c_A \tag{21}$$

$\Rightarrow$ Optimal $w' = w_l$ pushes amateur workers to reservation wage:

$$\widetilde{w}^{\max}(w_l, \mathbf{w}_{-j}) - w_l = c_A \tag{22}$$

Back

Wage-Setting: Worker Beliefs and Reservation Wages

- Simple setup: amateurs' priors are weighted avg of current wage and true max wage:

$$\tilde{w}^{\max} = g \cdot w_j + (1-g) \cdot w^{\max} \tag{23}$$

- $g \in [0,1]$ guides the degree of anchoring
- Since true max wage is the competitive wage w^*, optimal w' is:

$$w_l = w^* - \frac{c_A}{1-g} \tag{24}$$

- Higher search costs or stronger anchoring push down w_l

Back

Solving for the Equilibrium

- Profits in the competitive equilibrium:

$$p^{\text{competitive}} = \left(\frac{L}{N}\right)^{h} - h\left(\frac{L}{N}\right)^{h} \tag{25}$$

- Profits when deviating:

$$p^{\text{deviating}} = \left((1-a)\frac{L}{N}\right)^{h} - \left(h\left(\frac{L}{N}\right)^{h-1} - \frac{c_A}{1-g}\right)(1-a)\frac{L}{N} \tag{26}$$

Back

Equilibrium Consequences of Worker Misperceptions

- Presence of amateur workers with anchored beliefs can lead to shift from competitive equilibrium to segmented labor market with high- and low-wage sector
  - Search costs and anchoring amplify each other
- Comparative statics: more anchoring leads to
  - Lower wages in low-wage sector
  - Larger low-wage sector

Back

First Possibility: Competitive (One-Wage) Equilibrium

- If $p^{\text{competitive}} > p^{\text{deviating}}$, deviating is unprofitable and we get a normal competitive-wage equilibrium
- This occurs if:

$$\frac{c_A}{1-g} < \frac{1-ah-(1-a)^h}{1-a}\left(\frac{N}{L}\right)^{1-h} \tag{27}$$

- i.e., if search costs c_A are low, anchoring g is weak, or the share of experts a is high

Back

Second Possibility: Segmented Equilibrium

- Either competitive equilibrium or a segmented, two-wage equilibrium
- If $p^{\text{competitive}} < p^{\text{deviating}}$, some firms deviate and pay low wage w_l
- Deviating firms increase their profits (by assumption)
- Non-deviating pay high wage w_h, and firms absorb the experts from deviating firms, increasing their size and hence their profits
- Deviations continue until profits in deviating and non-deviating firms are equal:

$$\underbrace{\left((1-a)\frac{L}{N}\right)^{h} - w_l(1-a)\frac{L}{N}}_{\text{deviant (low-wage) profits}} = \underbrace{\left(\left(1-a+\frac{a}{b}\right)\frac{L}{N}\right)^{h} - w_h\left(1-a+\frac{a}{b}\right)\frac{L}{N}}_{\text{non-deviant (high-wage) profits}} \qquad (28)$$

where b is the share of high-wage (non-deviating) firms

Back

Employment Levels in the Segmented Equilibrium

- High-wage sector employs all experts and all "lucky" amateurs
- High-wage firms are large:

$$\ell_h = (1 - a + \frac{a}{b})\frac{L}{N} \tag{29}$$

- Low-wage sector employers all "unlucky" amateurs
- Low-wage firms are small:

$$\ell_l = (1 - a)\frac{L}{N} \tag{30}$$

- Turnover in the low-wage sector is higher (experts leave low-wage firms), consistent with reality

▸ Back

Wage Levels in the Segmented Equilibrium

- High-wage firms pay wages equal to MPL at ℓ_h

$$w_h = h\left(\left(1 - a + \frac{a}{b}\right)\frac{L}{N}\right)^{h-1} \tag{31}$$

- Low-wage firms pay the reservation wage preventing amateurs from searching

$$w_l = w_h - \frac{c_A}{1-g} \tag{32}$$

Back

The Size of the Low-Wage Sector

- Low-wage sector employs all amateurs born into low-wage firms

$\Rightarrow$ # of workers in low-wage sector depends on share of firms, $1-b$, that are low-wage, and share of workers, $1-a$, that are amateurs

- b pinned down by equal-profit condition

$$\underbrace{\left((1-a)\frac{L}{N}\right)^{h} - w_l(1-a)\frac{L}{N}}_{\text{deviant profits}} = \underbrace{\left(\left(1-a+\frac{a}{b}\right)\frac{L}{N}\right)^{h} - w_h\left(1-a+\frac{a}{b}\right)\frac{L}{N}}_{\text{non-deviant profits}} \tag{33}$$

- Given b, share of jobs that are low-wage is

$$S_l = \frac{1-b}{a/(1-a)+b} \tag{34}$$

Back

Share of Nonviable Jobs if Workers Had Correct Beliefs

- How consequential are these misperceptions?
- Back-of-the-envelope calculation: calculate share of jobs that would not be viable if workers had accurate beliefs

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Share of Nonviable Jobs with Corrected Beliefs

- How many jobs would not be viable at current wages if workers had correct beliefs?
- Draw on survey measure of subjective overall worker surplus:

  Imagine that your current employer permanently cut wages. This wage cut results from a change of the CEO in the company and is independent of the economic conditions in your industry. At which wage cut would you quit your job within one year?

  I would quit my job if my current employer cut wages by more than X%.

- Decompose overall subjective surplus into subjective wage component and nonwage component:

$$\underbrace{\widetilde{S}_i}_{\text{Worker Surplus}} = \underbrace{\widetilde{W}_i}_{\substack{\text{Wage Component} \\ \text{from OO Question}}} + \underbrace{\widetilde{A}_i.}_{\substack{\text{Residual "Amenity"} \\ \text{Component}}}$$

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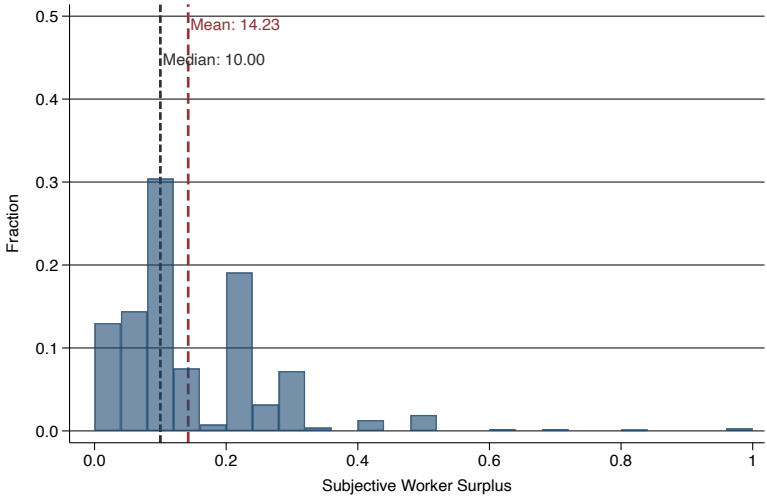
Subjective Worker Surplus (Flow, as % of Salary)



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Share of Nonviable Jobs with Corrected Beliefs

- Decompose overall subjective surplus into nonwage component and subjective wage component:

$$\underbrace{\widetilde{S}_i}_{\text{Worker Surplus}} = \underbrace{\widetilde{W}_i}_{\substack{\text{Wage Component} \\ \text{from OO Question}}} + \underbrace{\widetilde{A}_i.}_{\substack{\text{Residual "Amenity"} \\ \text{Component}}}$$

- Calculate corrected surplus by replacing subjective wage component with objective OO proxy:

$$\underbrace{S_i}_{\substack{\text{Worker Surplus:} \\ \text{Corrected}}} = \underbrace{\widetilde{S}_i}_{\substack{\text{Worker Surplus:} \\ \text{Belief}}} + \overbrace{\left(\underbrace{\widehat{W}_i}_{\substack{\text{Wage Change:} \\ \text{Objective Benchmark}}} - \underbrace{\widetilde{W}_i}_{\substack{\text{Wage Change:} \\ \text{Belief}}} \right)}^{\text{Belief Correction}}$$

- OO proxy: mean coworker wage change in AKM ventile, or machine learning prediction

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GSOEP Information Treatment First Stage

	(1) Post-Treat: Beliefs Own: Wage Change	(2) Intended Search Probability	(3) Intended Negotiation Probability	(4) Intended Neg Magnitude (No Neg = 0)	(5) Intended Neg Magnitude (No Neg = Msg)	(6) Reservation Wage Cut
Treated × Underestimate	1.925**	2.515	0.333	-1.906*	0.031	0.026
	(0.858)	(2.434)	(2.860)	(1.032)	(0.116)	(0.114)
Treated × Overestimate	-0.866	-0.288	-3.984	0.693	0.042	-0.008
	(1.230)	(2.760)	(3.668)	(1.056)	(0.148)	(0.142)
Overestimate	1.678	0.547	4.797	-1.750*	-0.024	0.028
	(1.121)	(2.558)	(3.440)	(1.050)	(0.137)	(0.130)
Constant	-1.958***	15.133***	20.548***	15.569***	3.319***	3.367***
	(0.598)	(1.684)	(2.149)	(0.777)	(0.083)	(0.082)
Nb. obs	1,241	1,236	1,234	1,241	1,241	1,220

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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Average Treatment Effect by Under - and Overestimators

	(1) Post-Treat Estimation Error	(2) Post-Treat Beliefs: Own Wage Change	(3) Intended Quit Probability	(4) Intended Search Probability	(5) Intended Negotiation Probability	(6) Intended Neg Magnitude (No Neg = 0)	(7) Reservation Wage Cut
Treated × Underestimate	9.166***	13.936***	4.051***	3.955***	5.787***	0.835***	-4.570
	(1.350)	(0.971)	(1.348)	(1.354)	(1.542)	(0.166)	(3.367)
Treated × Overestimate	-13.064***	-4.544***	-1.610	1.330	-4.373**	-0.497**	0.051
	(2.229)	(1.155)	(1.764)	(1.800)	(2.108)	(0.206)	(0.567)
Overestimate	36.354***	1.331	-1.383	-2.759*	3.661*	0.263	-4.097
	(2.032)	(1.014)	(1.577)	(1.566)	(1.869)	(0.186)	(3.378)
Constant	-14.370***	3.441***	23.538***	25.560***	37.294***	6.803***	13.232***
	(1.036)	(0.566)	(0.934)	(0.942)	(1.077)	(0.107)	(3.355)
Control for Pre-Treatment Belief							
Pre-Treatment Mean: Underestimate	-21.35	3.63					
Pre-Treatment Mean: Overestimate	20.11	4.34					
Nb. obs	3,206	3,206	3,206	3,206	3,206	3,206	3,204
IV: Belief: % Wage Change at OO			0.306***	0.142	0.550***	0.072***	-0.250
			(0.119)	(0.121)	(0.142)	(0.015)	(0.255)
Constant			22.485***	25.071***	35.402***	6.555***	14.099***
			(1.139)	(1.159)	(1.366)	(0.144)	(2.450)
Control Group Mean			23.055	24.595	38.574	6.895	11.799
First-Stage F-Stat			139.593	139.593	139.593	139.593	139.497

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