Wage markups and buyer power in intermediate input markets

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Motivation

- Growing literature suggests widespread monopsony power in US labor markets

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- **This paper** Studies the relationship between market imperfections in labor and intermediate input markets

Synopsis

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  - ➜ requires a methodological innovation

Outline

- **Part 1** Institutional details and theoretical framework
- **Part 2** Data and empirical approach
- **Part 3** Results

Labor market - Dutch institutional setting

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- Comparable systems in most of Western Europe

  e.g., Cardoso & Portugal (2005, JOLE); Card et al. (2014, RESTUD)

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- Setting conducive to buyer power **Morlacco (2020)**

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- Firms potentially have price setting power for intermediates
- Testable predictions that follow do not rely on origins of (potential) buyer power
- Many standard models are nested here

  monopsony, monopsonistic competition, bilateral bargaining, etc.

Theoretical model

Theoretical predicitons

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- Buyer power leads to intermediates price markdowns: $\gamma_{it}^{M} > 1$
- Wage markups increase in buyer power: $corr(\gamma_{it}^{L}, \gamma_{it}^{M}) < 0$

Robustness of predictions

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Identifying input wedges

Input wedges can be written as

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- θ_{it}^{x} is the revenue elasticity of input x

  to be estimated

- LS_{it} and MS_{it} are labor and intermediate input expenditure shares of revenue, respectively

  observed in financial statements

Related approaches

Estimating revenue elasticities

Revenue is given by

$$R_{it}(K_{it}, L_{it}, M_{it}) = F(K_{it}, L_{it}, M_{it})\Omega_{it}\varepsilon_{it},$$

where Ω_{it} is revenue productivity and ε_{it} is unanticipated revenue

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- Control function approach to estimate the revenue function

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- Results are robust to a variety of alternative approaches
- **Key insight** results are driven by expenditure shares, not revenue elasticities

Estimation details Robustness checks

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- Many small firms: median employment is 10 (mean = 23.33)

descriptives

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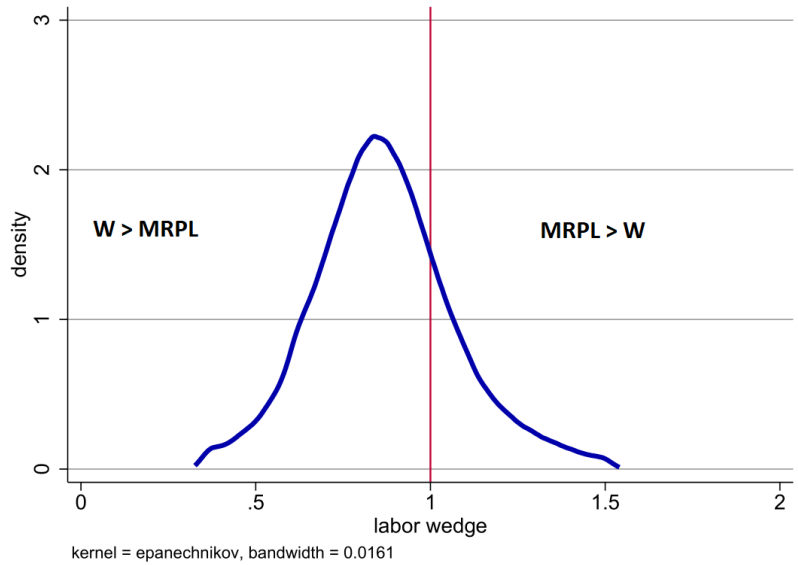
Input wedge distributions

Labor wedge $\left(\frac{MRPL_{it}}{W_{it}}\right)$



Notes: Kernel density functions of firm-level input wedges. Based on the full samples of 121,057 firm-year observations covering the years 2007 to 2018.

Descriptive Statistics

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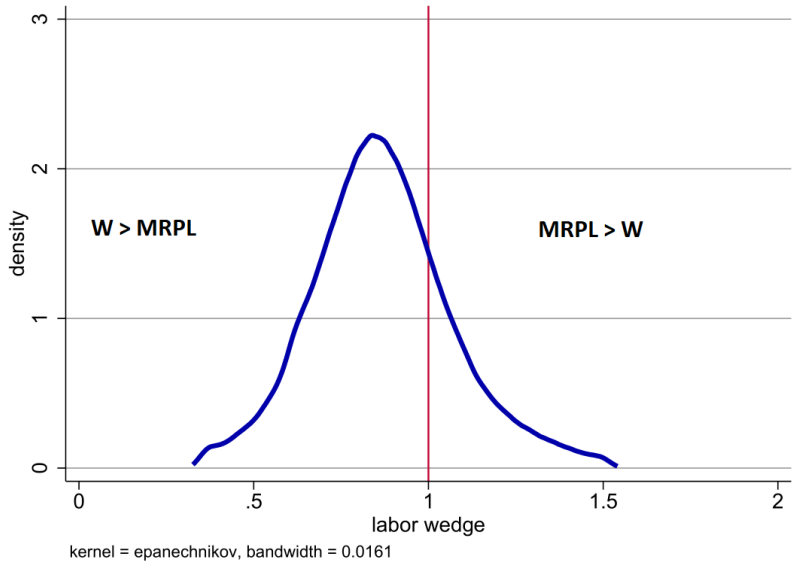

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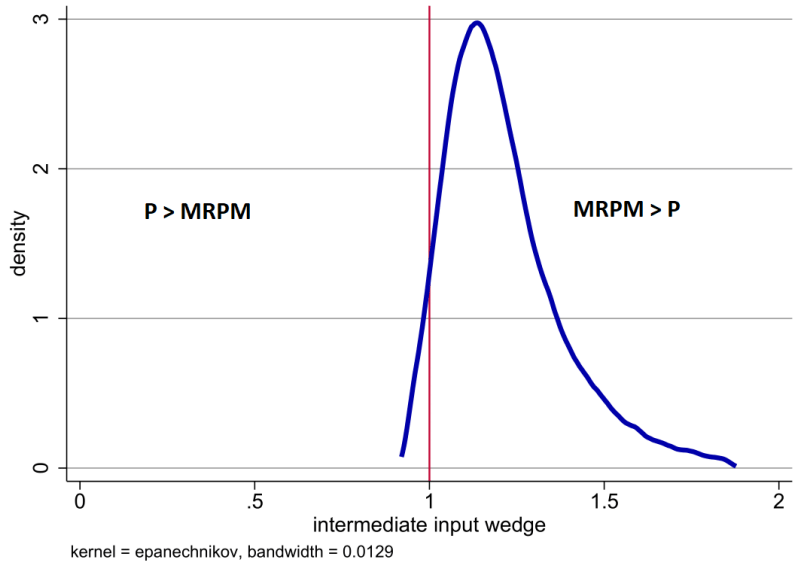

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Input wedge distributions, over time

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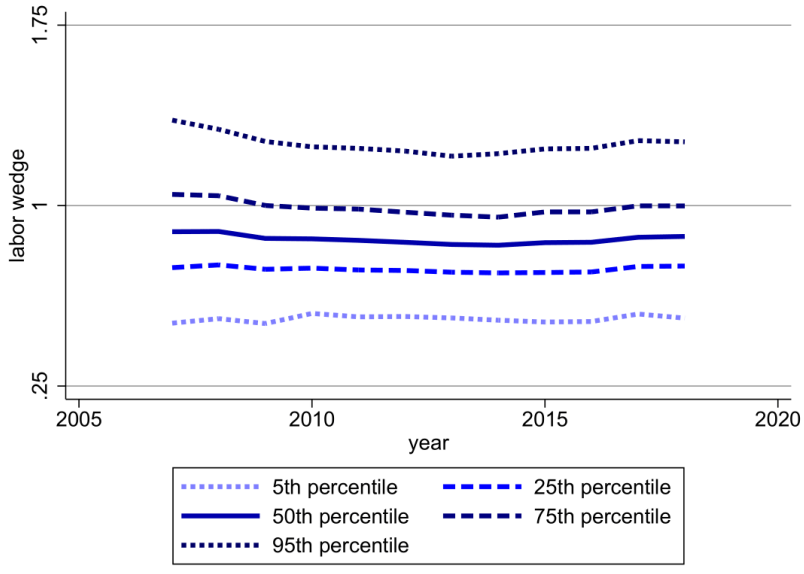

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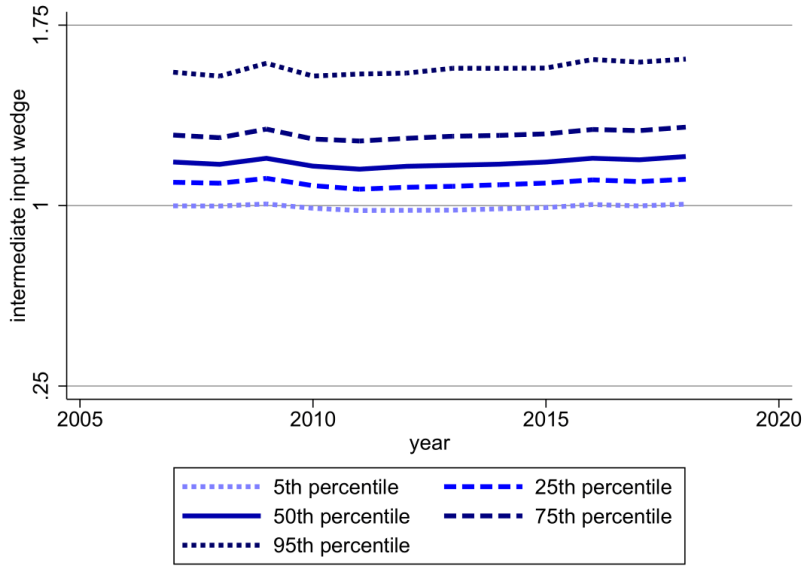

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Between-industry vs. within-industry differences

Explaining within industry-year wage markup variation

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- Standard errors clustered at the 4-digit industry level

Wage or productivity?

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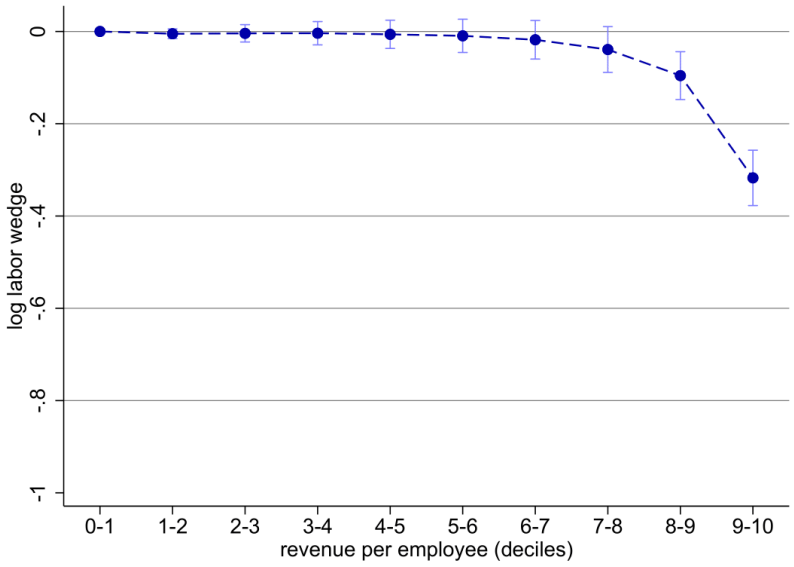

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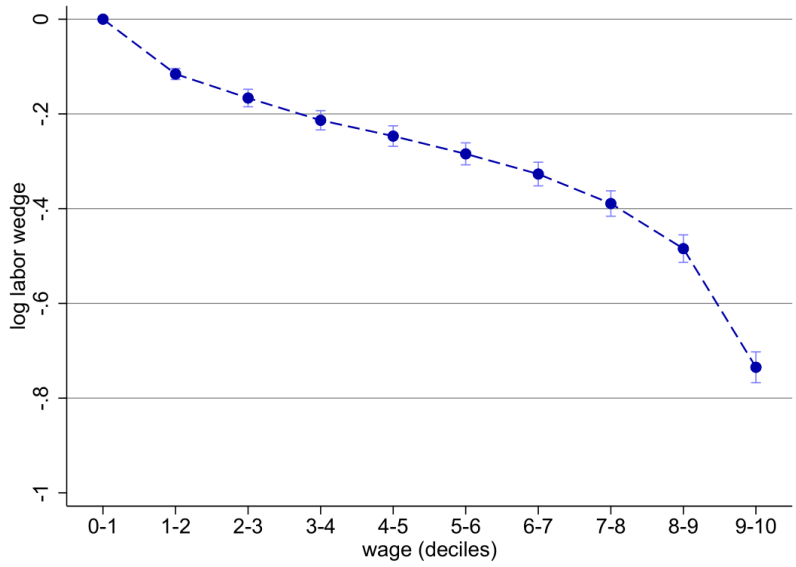

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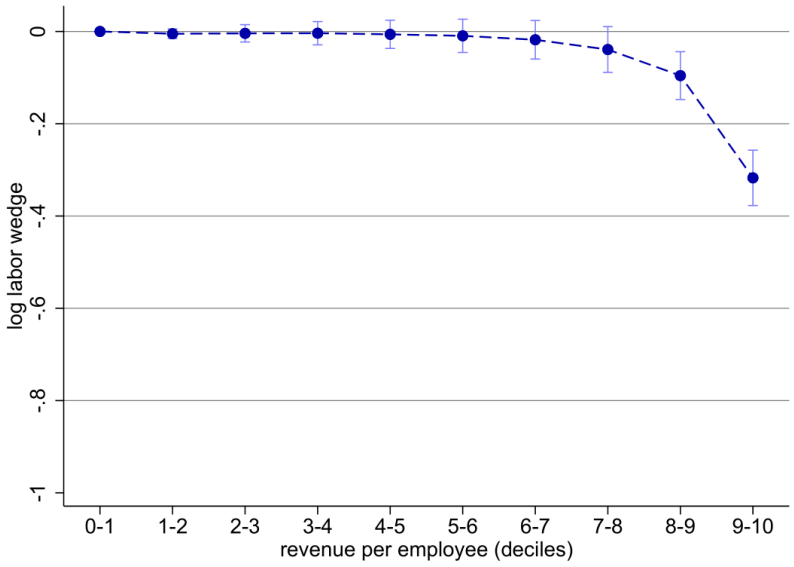

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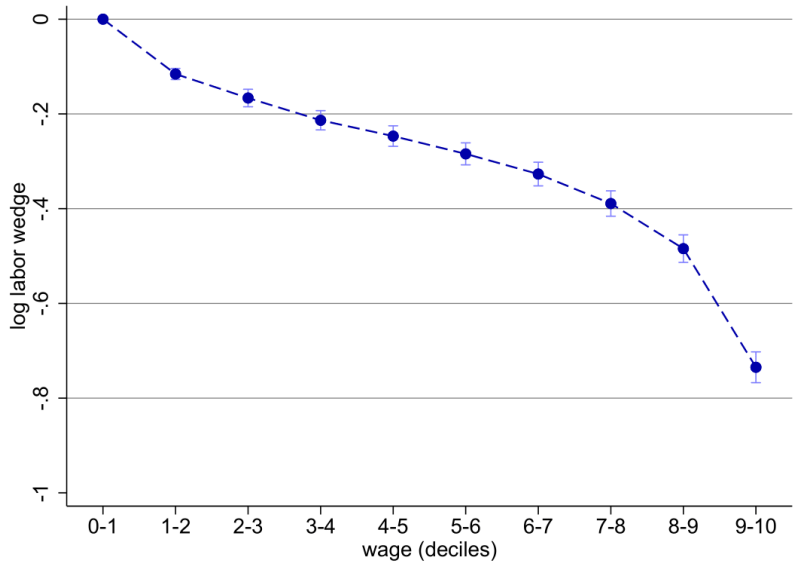

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Wage differences, not productivity differences, drive wage markup variation

Buyer power and wage markups

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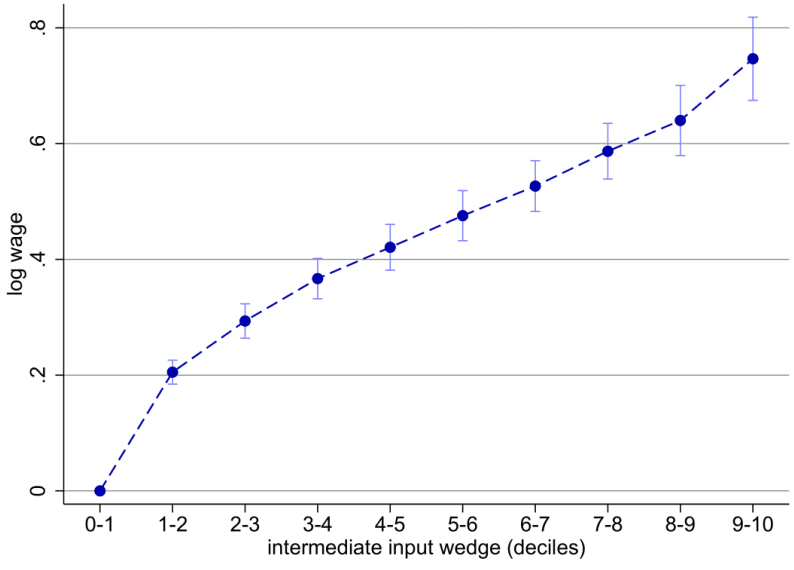

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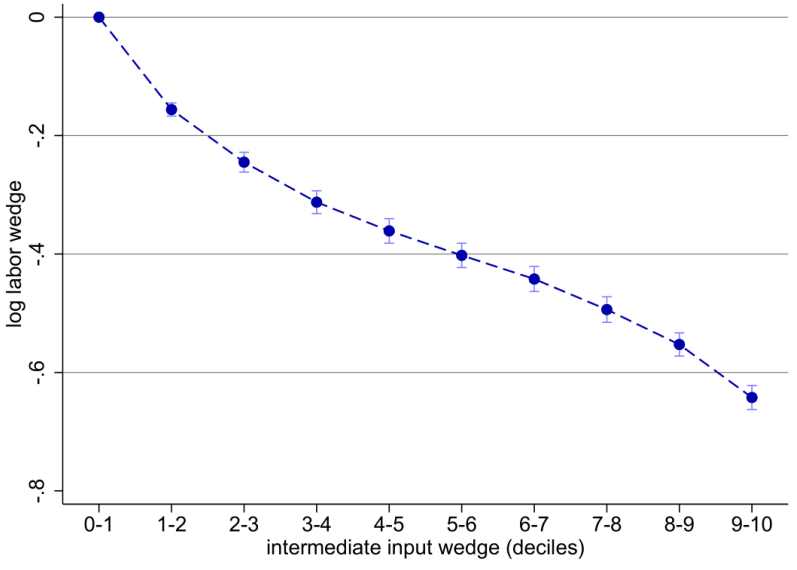

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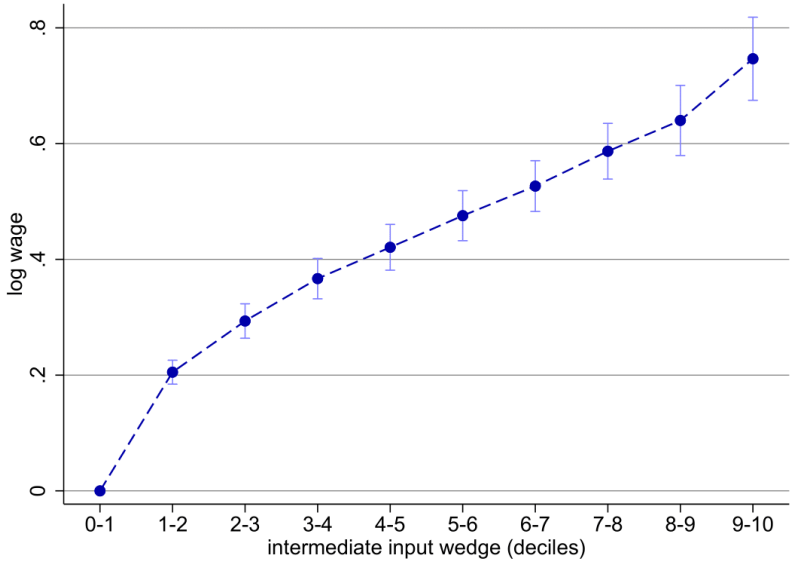

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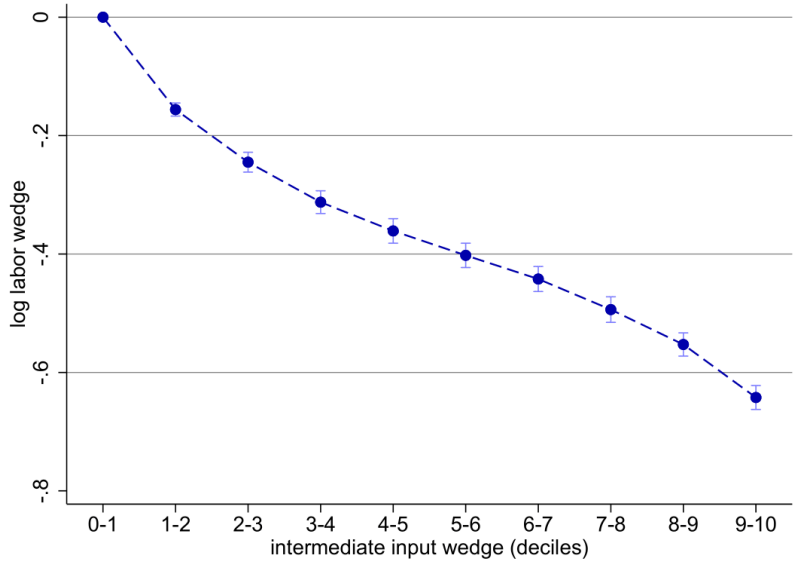

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Firms that exercise more buyer power pay higher wages, both in absolute terms and relative to the revenue contribution of their employees

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Quantifying rent sharing: for every 10% increase in rents, firms increase wages by 2% on average

Rent sharing estimation Rent sharing results

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What's the story?

Collective bargaining allows employees to extract rents. Buyer power increases rents. Cross-subsidization of input markets.

Appendix

Maximization problem

- Generalized Nash bargaining solution solves

$$\max_{L_{it},M_{it},W_{it}} (L_{it}(W_{it} - \bar{W}_{it}))^{\phi_{it}} (R_{it}(Q_{it}) - P_{it}^{K} K_{it} - W_{it} L_{it} - P_{it}^{M}(M_{it}) M_{it} - \bar{\Pi}_{it})^{1-\phi_{it}} \tag{1}$$

- ϕ_{it} denotes the bargaining power of the employee association ($0 < \phi_{it} < 1$).
- $\bar{\Pi}_{it}$ denotes the outside option of the firm
- I assume that labor, wages, and intermediate inputs are determined simultaneously

  predictions are unaffected if firms first bargain and then select intermediates
- Capital is assumed to be predetermined

back

Optimality conditions labor and wage

- The first-order conditions can be combined to yield

$$MRPL_{it} = \bar{W}_{it} \tag{2}$$

$$W_{it} = MRPL_{it} + \phi_{it} \left(\frac{QR_{it}}{L_{it}} \right) \tag{3}$$

  where $QR_{it} = R_{it}(Q_{it}) - P_{it}^{K} K_{it} - \bar{W}_{it} L_{it} - P_{it}^{M}(M_{it}) M_{it} - \bar{\Pi}_{it}$ are the firm's quasi rents

- Define the **labor wedge** as

$$\gamma_{it}^{L} = \frac{MRPL_{it}}{W_{it}} \tag{4}$$

- Equation (4) shows that $\gamma_{it}^{L} < 1$: wage markups occur

back

Optimality condition intermediate inputs

- The first-order condition can be written as

$$MRPM_{it} = P_{it}^{M}((\varepsilon_{it}^{M})^{-1} + 1) \tag{5}$$

- Define the **intermediate input wedge** as

$$\gamma_{it}^{M} = \frac{MRPM_{it}}{P_{it}^{M}} \tag{6}$$

- Equation (6) shows that $\gamma_{it}^{M} > 1$ if buyer power exists: intermediate input price markdowns occur

back

Robustness of predictions

Results are robust to

- Unoberved input heterogeneity
  input wedges are weighted averages of wedges of different input types
- Firms selecting intermediate inputs after the bargaining
- More elaborate bargaining setups
  multiple employee associations and multiple firms

back

Related approaches

- Petrin & Sivadasan (2013, RESTAT) estimate a revenue function to obtain the marginal revenue product of an input, and compare this to an industry-specific price index
- The 'cost minimization approach' applies the insights of De Loecker & Warzynski (2012, AER) to the labor market

  e.g., Mertens (2020, IJIO); Brooks et al. (2021, JDE); Yeh et al. (2022, AER)
- The cost minimization approach identifies the labor wedge *relative to the intermediate input wedge*, $\frac{\gamma_{it}^L}{\gamma_{it}^M}$, and assumes $\gamma_{it}^M = 1$
- Cost minimization approach works if
  - ➜ firms are price takers for intermediates, and
  - ➜ intermediates are frictionlessly adjustable
- I am not willing to make these assumptions given my setting

back

Estimating revenue elasticities

- Estimation closely follows the proxy-variable approach to production function estimation

  Olley & Pakes (1996); Levinsohn & Petrin (2001); Ackerberg et al. (2015)

- Log revenue is given by

$$r_{it} = f_{it}(k_{it}, l_{it}, m_{it}) + \omega_{it} + \epsilon_{it} \tag{7}$$

- ω_{it} is revenue productivity, potentially known to the firm when selecting its inputs, $f(\cdot)$ is a translog function
- Intermediate input demand is assumed to be invertible and equal to

$$m_{it} = m_s(\omega_{it}, k_{it}, l_{it}, \mathbf{x}_{it}^m), \tag{8}$$

- s is a 2-digit NACE industry, and $\mathbf{x}_{it}^m$ contains additional control variables such as the firm's average wage and 4-digit NACE industry materials share

back

Estimating revenue elasticities

- I observe quantity of labor, but expenditure on intermediate inputs
- Using deflated intermediate input expenditure in the place of intermediate input can generate a bias if input prices are firm-specific
- I control for this using

$$b_{it} = b_s((k_{it}, l_{it}, m_{it}) \times \mathbf{x}_{it}^b), \tag{9}$$

  where $\mathbf{x}_{it}^b$ contains market shares, industry and region indicators, and materials market shares
- Key idea is that materials market shares control for buyer power

  holds, for instance, in Morlacco's (2020) model of bilateral bargaining for intermediate inputs

back

Estimating revenue elasticities

- Estimation follows the two-step approach of Ackerberg et al. (2015)
- First step separates log revenue into "planned revenue" $\hat{r}_{it}$ and $\hat{\epsilon}_{it}$
- $\hat{\epsilon}_{it}$ is used to correct the input expenditure shares
- Next, assume that revenue productivity evolves according to

$$\omega_{it} = g_s(\omega_{it-1}) + \xi_{it}, \tag{10}$$

- In the second step, an estimate of ξ_{it} is obtained using equation (16), conditional on parameter values
- Parameters are identified by forming moments on ξ_{it}

$$\mathbb{E}((\xi_{it})\mathbf{Z}_{it}) = 0, \tag{11}$$

where $\mathbf{Z}_{it}$ contains instruments that are standard in the literature

back

Robustness checks

- Calibrate a single revenue elasticity for each input
  Does not require estimation at all
- Estimate a parsimonious specification without input price control
- Estimate revenue at the year-by-2-digit level
- Estimate revenue elasticities at the 4-digit level
- Alternative timing assumptions on labor
- Dynamic panel approach

back

Summary statistics

variable	p(25)	p(50)	p(75)	mean	s.d.
Nominal revenue	730	1,739	4,502	6,998	71,418
Nominal book value of capital	96	372	1,081	1,679	14,921
Labor (FTE)	4	10	23	23.33	56.24
Nominal labor expenditure	233	522	1,229	1,435	5,742
Nominal average wage	43	53	66	58	23
Labor share	0.22	0.31	0.41	0.32	0.15
Nominal intermediate input expenditure	377	970	2,731	4,939	65,464
Intermediate input share	0.48	0.58	0.69	0.58	0.15
Nominal EBIT	9	87	289	417	3,141

Notes: Summary statistics for key variables based on the full sample of 121,057 observations. EBIT is earnings before interest and taxes. p(25), p(50), and p(75) refer to the 25th, 50th, and 75th percentile of the distribution, respectively. Mean and s.d. are the unweighted mean and standard deviation. Monetary values in thousands, rounded to whole numbers. Non-monetary variables rounded to two decimal points.

back

Input wedges - Summary statistics

Table: Summary statistics of input wedges

	p(5)	p(25)	p(50)	p(75)	p(95)
Labor wedge	0.53	0.73	0.86	0.99	1.26
Intermediate input wedge	0.99	1.09	1.18	1.30	1.57

Notes: Summary statistics of the input wedges. p(5), p(25), p(50), p(75) and p(95) refer to the 5th, 25th, 50th, 75th and 95th percentile of the input wedge distribution, respectively. Input wedges are rounded to two decimal points. Statistics based on the full sample of 121,057 firm-year observations covering the years 2007 to 2018.

back

Input wedges - Dispersion by industry aggregation

Table: Input wedge statistics at different levels of industry aggregation

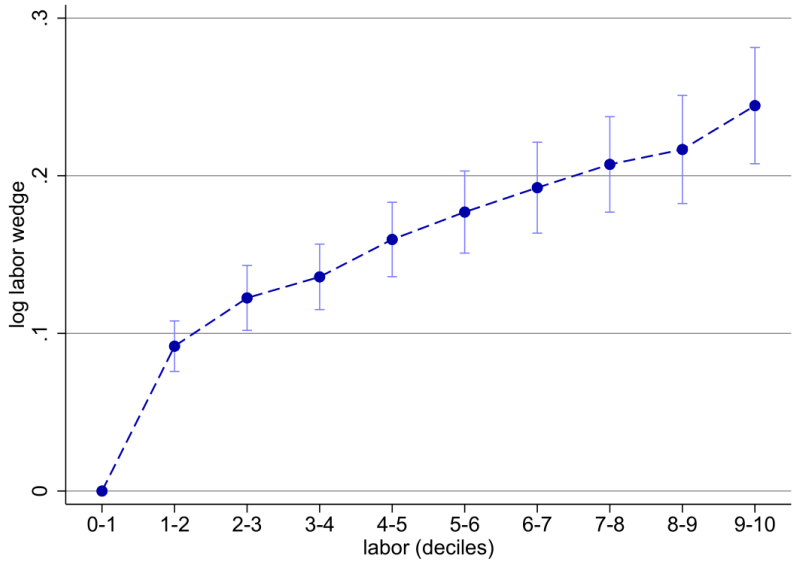
	Labor wedge			
Level	average p(50)	average p(75) - p(25)	average p(95) - p(5)	observations
Full sample	0.86 (-)	0.26 (-)	0.73 (-)	1
Division (2-digit)	0.84 (0.07)	0.26 (0.06)	0.74 (0.13)	18
Group (3-digit)	0.86 (0.08)	0.28 (0.09)	0.75 (0.18)	78
Code (4-digit)	0.86 (0.10)	0.27 (0.09)	0.73 (0.19)	167
	Intermediate input wedge			
Full sample	1.18 (-)	0.21 (-)	0.58 (-)	1
Division (2-digit)	1.18 (0.04)	0.21 (0.05)	0.58 (0.10)	18
Group (3-digit)	1.17 (0.07)	0.20 (0.06)	0.58 (0.13)	78
Code (4-digit)	1.17 (0.07)	0.19 (0.07)	0.54 (0.16)	167

Notes: Input wedge statistics at different levels of NACE industry classifications (more digits is a more narrowly defined industry). Averages are taken over all industries at the level, standard deviation in brackets. Number of units on which the average is based listed under "observations". p(5), p(25), p(50), p(75) and p(95) refer to the 5th, 25th, 50th, 75th and 95th percentile of the input wedge distribution, respectively. Input wedges are rounded to two decimal points.

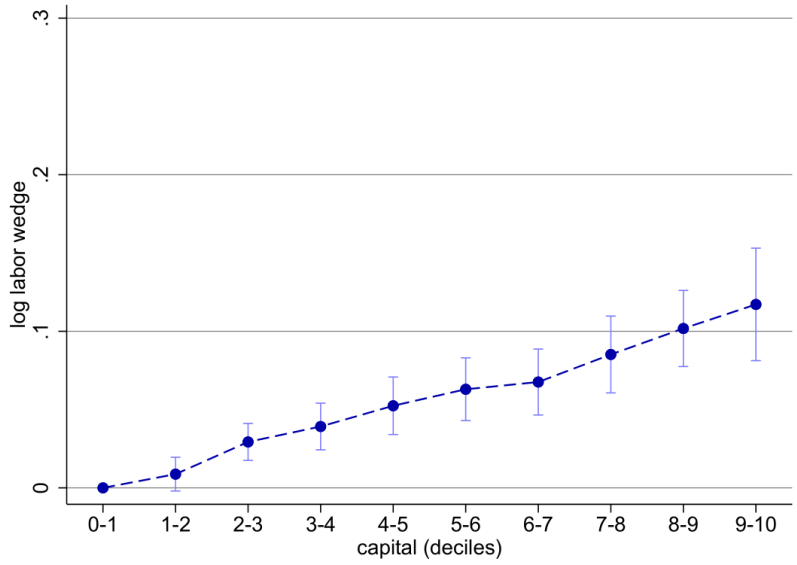
back

Wage markups and input use

Relation $\frac{MRPL_{it}}{W_{it}}$ and L_{it}



Relation $\frac{MRPL_{it}}{W_{it}}$ and K_{it}

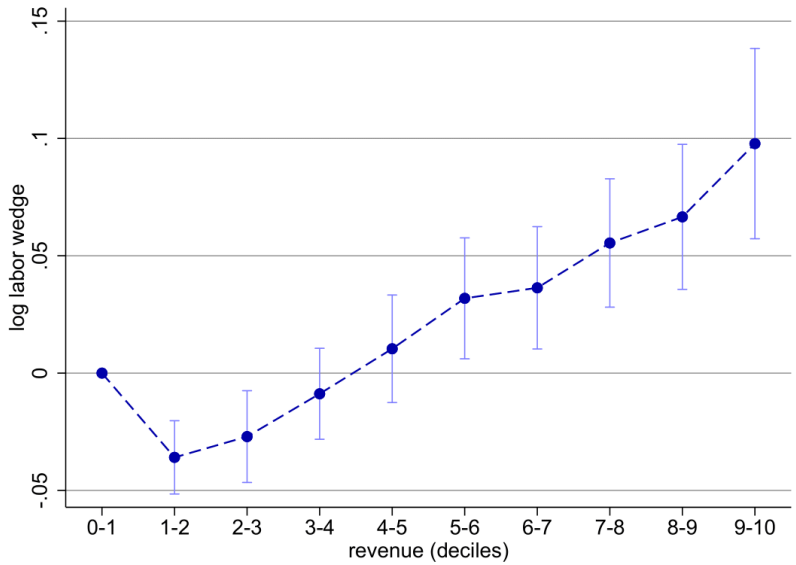


Notes: Regressions based on the full samples of 121,057 firm-year observations covering the years 2007 to 2018. Year by 4-digit NACE industry fixed effects included.

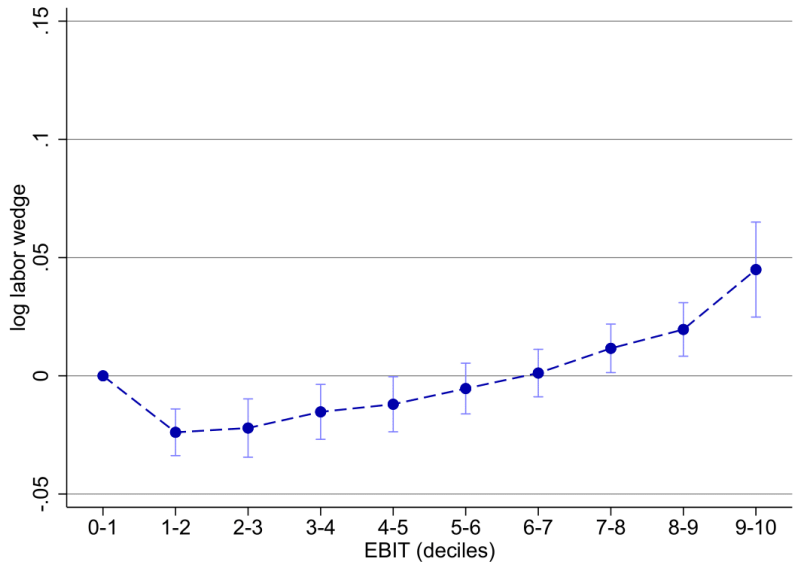
back

Wage markups, revenue, and EBIT

Relation $\frac{MRPL_{it}}{W_{it}}$ and R_{it}



Relation $\frac{MRPL_{it}}{W_{it}}$ and $EBIT_{it}$



Notes: Regressions based on the full samples of 121,057 firm-year observations covering the years 2007 to 2018. Year by 4-digit NACE industry fixed effects included.

back

Rent sharing

- The bargaining setup introduced earlier implies that

$$W_{it} = \bar{W}_{it} + \phi_{it}\left(\frac{QR_{it}}{L_{it}}\right), \tag{12}$$

  where $QR_{it} = R_{it}(Q_{it}) - P_{it}^{K}K_{it} - \bar{W}_{it}L_{it} - P_{it}^{M}(M_{it})M_{it} - \bar{\Pi}_{it}$.
- A large literature attempts to estimate the elasticity of wages with respect to quasi-rents per employee

$$\varepsilon_{it}^{W} = \frac{\phi_{it}(\frac{QR_{it}}{L_{it}})}{\bar{W}_{it} + \phi_{it}(\frac{QR_{it}}{L_{it}})}. \tag{13}$$

- As $\bar{W}_{it}$, $\bar{\Pi}_{it}$ and p_{it}^{K} are unobserved, most studies instead relate log wage to log value added per employee and controls
- This restricts ε_{it}^{W} to be constant at the level of estimation

back

Rent sharing

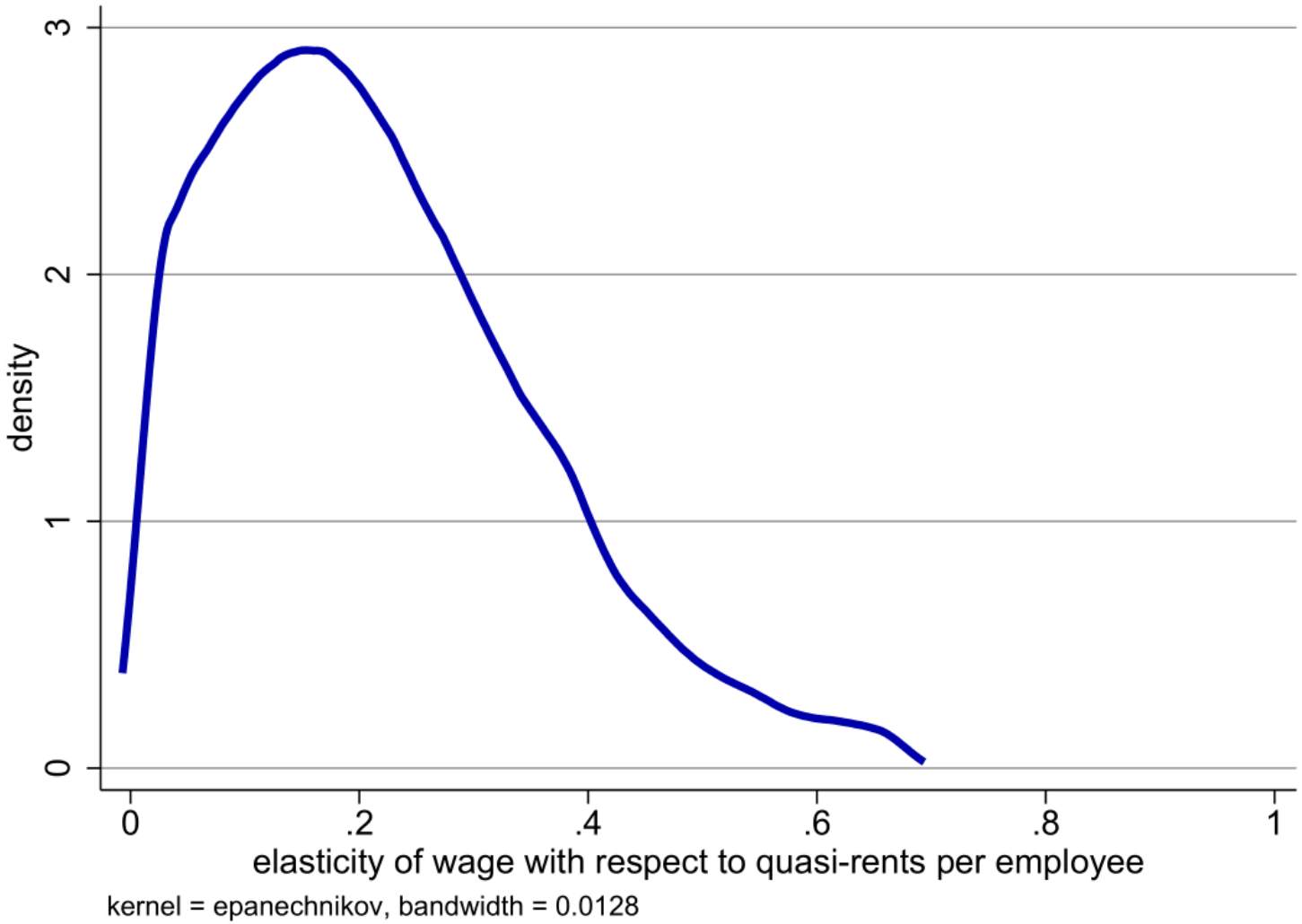
- The rent sharing elasticity can be rewritten as

$$\varepsilon_{it}^{W} = \frac{W_{it}L_{it} - \theta_{it}^{L}R_{it}}{W_{it}L_{it}} \left(= \frac{W_{it} - MRPL_{it}}{MRPL_{it}} \right). \tag{14}$$

- The rent sharing elasticity is a firm-time specific "Lerner index" wage markup, and can be calculated based on wage expenditure, revenue, and the revenue elasticity of labor
- This relies on firms equalizing the marginal revenue product of labor and the outside option wage in an efficient bargaining setting

back

Rent sharing elasticities



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Rent sharing elasticities

Table: Summary statistics of rent sharing elasticities

	p(5)	p(25)	p(50)	p(75)	p(95)
Rent sharing elasticity	0.03	0.11	0.20	0.31	0.51

Notes: Summary statistics of the elasticity of wage with respect to quasi-rents per employee. p(5), p(25), p(50), p(75) and p(95) refer to the 5th, 25th, 50th, 75th and 95th percentile of the input wedge distribution, respectively. Percentiles are rounded to two decimal points. Statistics based on the sample of 92,568 firm-year observations for which $\gamma_{it}^{L} < 1$.

- Median rent sharing elasticity is 0.2, mean is 0.22
- These estimates are comparable to those found in the literature
  e.g., Van Reenen (1996); Kline et al. (2019)
- Estimating a single elasticity based on regressions of wage on value added per employee yields (constructed) rent-sharing elasticities comparable to the mean elasticity presented here. see Card et al. (2018) for an overview

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