Imperfect Competition and Rents in Labor and Product Markets: The Case of the Construction Industry

Kory Kroft, Yao Luo, Magne Mogstad, Bradley Setzler

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Motivation

Two sources of market power are the focus of distinct literatures:

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Furthermore, we characterize rents, rent-sharing, and the incidence of government procurements in an environment with both sources of market power.

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Empirical context: We link the universe of U.S. **firm** and **worker** tax returns with records we collected from **procurement auctions**.

This Paper (1/2)

Framework for jointly analyzing **labor** and **product** market power.

- **Distinguish** supply and demand factors in both markets.
- **Closed-form** identification of all model parameters.
- **Measures** of rents and incidence of procurement.
- **Counterfactual** changes to power in either market.

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- **Challenge:** Unobserved firm-specific labor supply shocks.
- **Approach:** Leverage institutional features of the **auction** to isolate an observable firm-specific labor demand shock.
- **Preview:** Labor supply elasticity $\approx$ 4, wage markdown 20%.

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Identify returns to labor and product demand elasticities:

- **Challenge:** Unobserved firm-specific productivity shocks.
- **Approach:** Invert the bidding strategy in the **auction**.
- **Preview:** technology $\approx$ CRS, 16% price markup.

This Paper (2/2)

Model estimates:

- **Labor market power:** Wage **markdown** 20% below MRPL.
- **Double markdown:** MRPL depends on price **markup**. Accounting for **markup**, **double markdown** on wages is 31%
- **Double markup:** MC depends on wage **markdown**. **Double markup** on price is 44%, versus 16% ignoring markdown.

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- **Theoretical finding:** impacts of **labor market power** are attenuated by existence of **product market power**.
- **Intuition:** Cut **employment** to exploit **labor** $\implies$ less **output** means higher **prices** $\implies$ mitigates incentive to cut.

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- **Quantitative finding:** Reducing labor supply elasticity in half,
  - if the firm were a **price-taker**: 27% less employment
  - with **product market power**: 15% less employment

Related Literature

Wage inequality, imperfect competition, compensating differentials

- Rosen 1986; Murphy and Topel 1990; Gibbons and Katz 1992; Abowd Lemieux 1993; Abowd et al 1999; Hamermesh 1999; Pierce 2001; Bhaskar et al 2002; Manning 2003, 2011; Mas and Pallais 2017; Wiswall and Zafar 2017; Card et al 2013, 2016, 2018; Maestas et al 2018; Caldwell Oehlsen 2018; Berger et al 2019; Jarosch et al 2019; Chan et al 2020; Bassier et al 2020; Hershbein et al 2020; Azar Berry Marinescu 2020; many more

Inferring monopsony from pass-through of firm-specific shocks

- van Reenen 1996; Kline et al 2019; Howell Brown 2020; Lamadon Mogstad Setzler 2022; Garin Silvério 2023

Empirical designs for auctions

- Ferraz et al 2015; Lee 2017; Cho 2018; Hvide Meling 2019; Gugler et al 2020

Outline

1. **Framework with Labor and Product Market Power**
2. Double Market Power
3. Data Sources
4. Recovering Key Model Parameters
5. Estimates of Double Market Power
6. Estimates of Rents and Incidence
7. Counterfactual Labor and Product Market Power

Model

We develop a model with imperfect competition in both **labor** and **product** markets.

The model serves several purposes:

- **Distinguish** supply and demand factors in both markets.
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Key equations provided by the model in **blue**, they will be:

- Labor supply curve
- Product demand curve
- Optimal intermediate inputs
- Optimal auction bid
- Rents expression

Labor Market

Preferences If employed by firm j at wage W_{jt}, worker i utility is

$$\mathcal{U}_{it}(j, W_{jt}) = \log W_{jt} + \log G_{jt} + \eta_{ijt} \tag{1}$$

- G_{jt} is common, gives rise to *vertical* differentiation
- η_{ijt} is idiosyncratic to worker i, gives *horizontal* differentiation

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Firm-specific labor supply curve:

$$W_{jt} = L_{jt}^{\theta} U_{jt} \quad \Longrightarrow \quad w_{jt} = \theta \ell_{jt} + u_{jt} \tag{2}$$

where $1/\theta$ is the LS elasticity and U_{jt} is the firm-specific amenity

- Strategically small: no firm can shift aggregate labor supply

Technology

Production Function Firms produce using labor L, capital K, and intermediate inputs M in the Ackerberg et al (2015) technology,

$$Q_{jt} = \min\{\Omega_{jt} L_{jt}^{\beta_L} K_{jt}^{\beta_K}, \beta_M M_{jt}\} \exp(e_{jt}) \tag{3}$$

where Ω_{jt} is TFP and e_{jt} is measurement error in output

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Composite Production If capital market is perfect, simplifies to

$$Q_{jt} = \min\{\Phi_{jt} L_{jt}^{\rho}, \beta_M M_{jt}\} \exp(e_{jt}) \tag{4}$$

where ρ is composite labor returns and Φ_{jt} is composite TFP. ▸ +

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Optimal intermediate inputs Defining $X_{jt} \equiv p_M M_{jt}$, the Leontief FOC and competitive market for intermediate inputs gives,

$$X_{jt} = \frac{p_M}{\beta_M} L_{jt}^{\rho} \Phi_{jt} \quad \Longrightarrow \quad x_{jt} = \kappa_X + \rho \ell_{jt} + \phi_{jt} \tag{5}$$

Firm's Problem

Output Let G denote govt market and H denote private market. Denote output in G by Q_{jt}^{G} and in H by Q_{jt}^{H}

- First-stage: Firms bid to produce $\bar{Q}^{G}$, $D_{jt} = 1$ if winner
- Second-stage: Choose total output $Q_{jt} = \bar{Q}^{G} D_{jt} + Q_{jt}^{H}$

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Private Market Firms face downward-sloping demand,

$$P_{jt}^{H} = p_{H} \left(Q_{jt}^{H} \right)^{-\epsilon} \implies R_{jt}^{H} = p_{H} \left(Q_{jt}^{H} \right)^{1-\epsilon} \implies r_{jt}^{H} = \kappa_{R} + (1-\epsilon) q_{jt}^{H} \quad (6)$$

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Firm's Problem Given $Q_j \geq \bar{Q}^G d$ and auction outcome $D_j = d$,

$$\max_{L_{djt}, K_{djt}, M_{djt}} \quad \pi_{djt}^H = R_{djt}^H - W_{djt} L_{djt} - p_M M_{djt} - p_K K_{djt} \quad (7)$$

subject to the labor supply curve, the product demand curve, and the production function.

Government Market for Procurements

Opportunity Cost Given private market profits π^H_{djt} if $D_{jt} = d$,

$$\sigma_u(\phi_{jt}) = \pi^H_{0jt} - \pi^H_{1jt} > 0, \tag{8}$$

Auction problem Firm j chooses optimal bid Z_{jt} that solves,

$$\max_{Z_{jt}} \underbrace{(Z_{jt} - \sigma_u(\phi_{jt}))}_{\text{payoff}} \times \underbrace{\Pr(D_{jt} = 1 | Z_{jt})}_{\text{probability of winning}} \tag{9}$$

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Optimal bid Unique symmetric equilibrium is defined by,

$$s_u(\phi_{jt}) = \sigma_u(\phi_{jt})\,\delta_u(\phi_{jt}),\ \delta_u(\phi_{jt}) \equiv 1 + \frac{\int_{\sigma_u(\phi_{jt})}^{\bar{\sigma}} [1 - F_u(\tilde{\sigma})]^{I-1} d\tilde{\sigma}}{\sigma_u(\phi_{jt})\,[1 - F_u(\sigma_u(\phi_{jt}))]^{I-1}}$$

where I is number of bidders and δ is markup on opportunity cost

Defining Worker Rents

Worker Rents The rents V_{it} derived by worker i from being employed at the preferred firm j is defined implicitly by,

$$\underbrace{\mathcal{U}_{it}\left(j, W_{jt} - V_{it}\right)}_{\substack{\text{utility at current employer} \\ \text{net of worker rents}}} \quad = \quad \underbrace{\max_{j' \neq j} \mathcal{U}_{it}\left(j', W_{j't}\right)}_{\text{utility at best outside option}}$$

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Sum of Worker Rents Using our functional form to simplify,

$$V_{jt} \equiv \sum_i V_{ijt} = \frac{B_{jt}}{1 + 1/\theta} \tag{10}$$

where $B_{jt} = L_{jt} W_{jt}$ is the wage bill and $1/\theta$ is LS elasticity

Incidence of Procurements

$$\underbrace{V_{\Delta jt}}_{\text{Incidence}} = \underbrace{V_{1jt}}_{\text{Rents for winners}} - \underbrace{V_{0jt}}_{\text{Rents for losers}} = \frac{B_{1jt} - B_{0jt}}{1 + 1/\theta} \qquad (11)$$

Rents and Incidence

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Incidence for Incumbents and New Hires

$$\underbrace{V_{\Delta jt}}_{\text{Incidence}} = \underbrace{L_{0jt}\left(W_{1jt} - W_{0jt}\right)}_{\text{Incidence for incumbents}} + \underbrace{W_{1jt}\left(L_{1jt} - L_{0jt}\right) - \frac{B_{1jt} - B_{0jt}}{1 + \theta}}_{\text{Incidence for new hires}}.$$

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Firm Rents

$$\underbrace{\pi_{\Delta jt}}_{\text{Incidence on firms}} = \underbrace{\pi_{1jt}}_{\text{Rents for winners}} - \underbrace{\pi_{0jt}}_{\text{Rents for losers}} \tag{12}$$

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2. **Double Market Power**
3. Data Sources
4. Recovering Key Model Parameters
5. Estimates of Double Market Power
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7. Counterfactual Labor and Product Market Power

First-order Condition

Simple Firm's Problem: Consider a firm that does not participate in procurement auctions. The firm's problem simplifies to,

$$\max_{L_{jt},K_{jt},M_{jt}} \quad \pi_{jt} = Q_{jt}P_{jt} - W_{jt}L_{jt} - p_M M_{jt} - p_K K_{jt}$$

subject to the constraints,

$$\begin{aligned} \text{Flexible prod. func.:} \qquad & Q_{jt} = f_{jt}(L_{jt}, K_{jt}, M_{jt}) \\ \text{Monopolistic comp.:} \qquad & P_{jt} = p_H \left(Q_{jt}\right)^{-\epsilon} \\ \text{Monopsonistic comp.:} \qquad & W_{jt} = L_{jt}^{\theta} U_{jt} \end{aligned}$$

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First-order Condition w.r.t. Labor:

$$\underbrace{(1-\epsilon) \; \times \; P_{jt} \, \text{MPL}_{jt}}_{\text{MRPL}_{jt}} \quad = \quad \underbrace{(1+\theta) \; \times \; W_{jt}}_{\text{MCL}_{jt}}$$

where $\text{MPL}_{jt} \equiv \frac{\partial Q_{jt}}{\partial L_{jt}}$, $\text{MRPL}_{jt} \equiv \frac{\partial \left(P_{jt} Q_{jt}\right)}{\partial L_{jt}}$, and $\text{MCL}_{jt} \equiv \frac{\partial \left(W_{jt} L_{jt}\right)}{\partial L_{jt}}$.

Double Market Power

$$\text{FOC:} \quad \underbrace{(1-\epsilon) \times P_{jt}\,\mathsf{MPL}_{jt}}_{\mathsf{MRPL}_{jt}} = \underbrace{(1+\theta) \times W_{jt}}_{\mathsf{MCL}_{jt}} \tag{13}$$

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Markdown and Markup: Rearranging the FOC,

$$W_{jt} = \overbrace{(1+\theta)^{-1}}^{\text{markdown}} \times \mathsf{MRPL}_{jt} \qquad \textit{and} \qquad P_{jt} = \overbrace{(1-\epsilon)^{-1}}^{\text{markup}} \times \frac{\mathsf{MCL}_{jt}}{\mathsf{MPL}_{jt}}$$

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Double markdown: Substituting into the **wage** expression,

$$W_{jt} = \underbrace{\overbrace{(1+\theta)^{-1}}^{\text{markdown}} \times \overbrace{(1-\epsilon)}^{\text{inverse markup}}}_{\text{double markdown}} \times \underbrace{P_{jt}\,\text{MPL}_{jt}}_{\text{value of MPL}} \qquad (14)$$

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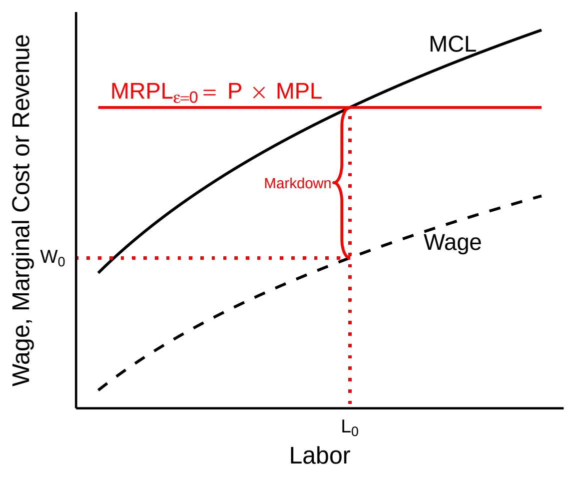
Double markup: Substituting into the **price** expression,

$$P_{jt} = \underbrace{\overbrace{(1-\epsilon)^{-1}}^{\text{markup}} \times \overbrace{(1+\theta)}^{\text{inverse markdown}}}_{\text{double markup}} \times \underbrace{\frac{W_{jt}}{\text{MPL}_{jt}}}_{\text{prod.-adjusted wage}} \tag{15}$$

Single Markdown

MCL $= (1+\theta) \times$ Wage, where $1/\theta$ is LS elasticity.

MRPL $= (1-\epsilon) \times$ P $\times$ MPL, where $1/\epsilon$ is PD elasticity.



Perfect competition in the product market: $\epsilon = 0$.

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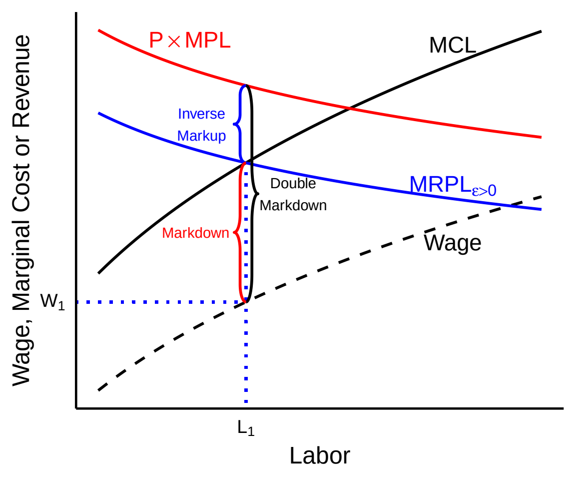
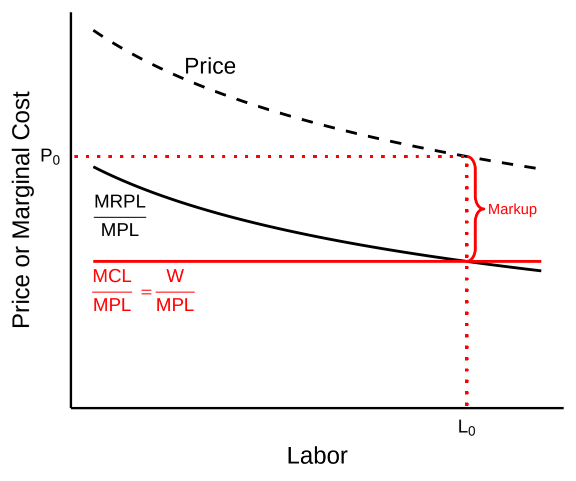


Imperfect competition in the product market: $\epsilon > 0$.

Single Markup

$$\frac{\text{MCL}}{\text{MPL}} = (1+\theta) \times \frac{\text{Wage}}{\text{MPL}}, \qquad \frac{\text{MRPL}}{\text{MPL}} = (1-\epsilon) \times \text{Price}$$



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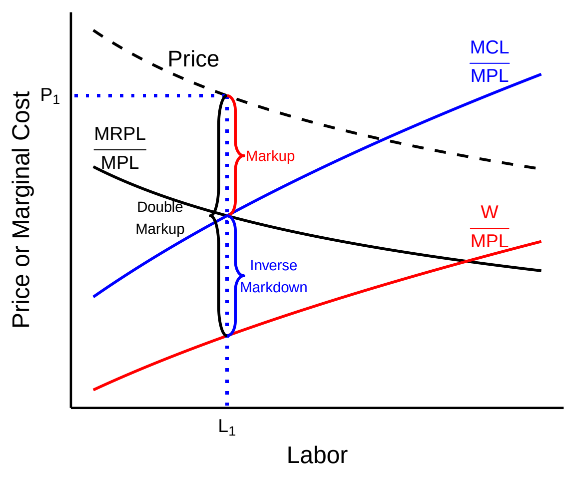

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Data Sources (1/2)

US tax data 2001-15 universe of business and worker tax returns

Firms: Business tax returns include balance sheet and other information for C-corps, S-corps, and partnerships

- **firm:** tax entity (EIN)
- **sales:** gross receipts from business operations (not dividends)
- **profits:** EBITD (earnings before interest, taxes, deductions)
- **intermediate inputs:** COGS (cost of goods sold)
  - includes intermediate goods, transit costs, etc
  - excludes durables, overhead, labor costs, etc

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Workers: W-2 records on employment and total earnings

- **labor:** link workers to their highest-paying employer with earnings above FTE threshold, restrict to age 25-60
- **contractors:** also observe indep. contractors (Form 1099)

Data Sources (2/2)

Auction data Firm-auction records on bids and winners of department of transportation (DOT) procurement contracts

- state DOTs use auctions to procure construction and landscaping work on roads and bridges
- First-price sealed-bid auctions (output price = lowest bid), where we observe bid of each firm, not only the winner
- FOIA or webscraped from BidX.com & state-specific websites
- Cover more than **100,000** auctions by 28 state DOTs, including large states like California, Texas, and Florida
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Data Sources (2/2)

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Final data Link tax returns to auction records by fuzzy matching on firm name and address

- Final data: **8,000** unique firms, **360,000** unique workers
- 6 states provide EIN, used for training algorithm & robustness

Descriptive Statistics for the Linked Sample

	Sample Size		Share of the Construction Sector
Number of Firms	7,876		0.9%
Workers per Firm	46		11.7%
	Value Per Firm ($ millions)	Mean of the Log	Share of the Construction Sector (%)
Sales	19.927	15.061	12.1%
EBITD	9.159	14.075	9.6%
Intermediate Costs	14.661	14.719	12.4%
Wage bill	2.737	13.549	13.4%

- Final sample: 8,000 unique firms, 360,000 unique workers
- Average firm has 46 employees and $9M in profits

Outline

1. Framework with Labor and Product Market Power
2. Double Market Power
3. Data Sources
4. **Recovering Key Model Parameters**
5. Estimates of Double Market Power
6. Estimates of Rents and Incidence
7. Counterfactual Labor and Product Market Power

Recovering Key Model Parameters

Using the key equations provided by the model that were in **blue** above, we now identify and estimate:

- **Labor supply** elasticity (4 slides)
- **Firm technology** & **product demand** elasticities (2 slides)

Labor Supply Elasticity (1/4)

Goal: Identify the labor supply elasticity, $1/\theta$.

Model: Log inverse labor supply curve is,

$$w_{jt} = \theta \ell_{jt} + u_{jt} = \theta \ell_{jt} + \psi_j + \xi_t + \nu_{jt} \tag{16}$$

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Easy to deal with:

- Time-invariant firm-specific amenities ψ_j (take differences)
- Aggregate labor supply shocks $\Delta\xi_t$ (add year fixed effects)

$$\Delta w_{jt} = \theta \Delta \ell_{jt} + \Delta \xi_t + \Delta \nu_{jt} \tag{17}$$

Challenge: Regression of change in log wage on change in log employment biased for θ due to firm-specific amenity shock $\Delta\nu_{jt}$

Labor Supply Elasticity (2/4)

Difference-in-differences. Consider the DiD estimator,

$$\theta_{\text{DiD}} \equiv \frac{\text{Cov}\left[\Delta w_{jt}, D_{jt}\right]}{\text{Cov}\left[\Delta \ell_{jt}, D_{jt}\right]} = \underbrace{\frac{\text{Cov}\left[\theta \Delta \ell_{jt}, D_{jt}\right]}{\text{Cov}\left[\Delta \ell_{jt}, D_{jt}\right]}}_{\theta} + \underbrace{\frac{\text{Cov}\left[\Delta \nu_{jt}, D_{jt}\right]}{\text{Cov}\left[\Delta \ell_{jt}, D_{jt}\right]}}_{\text{winning due to amenity shock}}$$

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DiD Identification. If $D_{jt} \perp \Delta \nu_{jt}$, then $\theta_{\text{DiD}} = \theta$.

Possible justification: $\Delta \nu_{jt}$ not in information set at "First Stage" of t when bid is placed in auction.

- Delay is between *estimating* labor cost (bidding at beginning of period t) and actually hiring labor (middle of period t). How well does cost estimation software predict $\Delta \nu_{jt}$?

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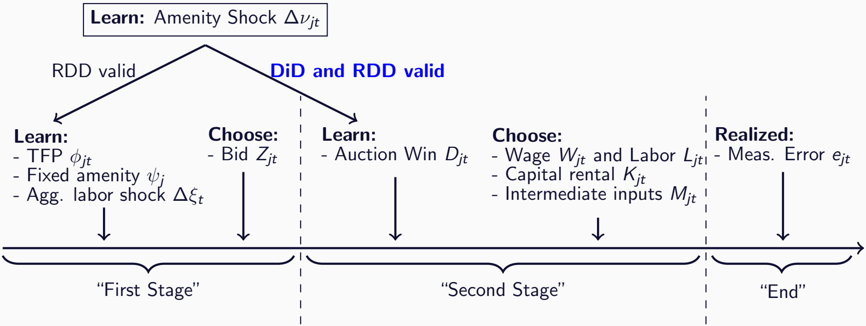
- Time delay assumptions are standard for identification in empirical IO (Ackerberg et al 2015; Gandhi et al 2020).

Important to emphasize what is **not** restricted by this assumption:

- no additional restrictions on joint dist of $(Z_{jt}, D_{jt}, \phi_{jt}, \psi_j, \xi_t)$.
- allows $\text{Var}(\Delta \nu_{jt}) > 0$, clear step forward in this literature.
- allows $\Delta \ell_{jt}, \Delta w_{jt}$ to depend on $\Delta \nu_{jt}$, no time delay here.

Sequence of Events within Time Period t



Labor Supply Elasticity (3/4)

Alternative: Leverage auction structure to allow selection.

Regression Discontinuity: Consider the estimator,

$$\theta_{RDD}(\overline{\tau}) \equiv \frac{\mathbb{E}\left[\Delta w_{jt} | \tau_{jt} = 0\right] - \mathbb{E}\left[\Delta w_{jt} | 0 < \tau_{jt} \leq \overline{\tau}\right]}{\mathbb{E}\left[\Delta \ell_{jt} | \tau_{jt} = 0\right] - \mathbb{E}\left[\Delta \ell_{jt} | 0 < \tau_{jt} \leq \overline{\tau}\right]}$$

where $\overline{\tau}$ is the maximum distance from winner-loser threshold.

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where $\overline{\tau}$ is the maximum distance from winner-loser threshold.

Limit around the discontinuity:

$$\lim_{\overline{\tau} \to 0^+} \theta_{RDD}(\overline{\tau}) = \theta + \lim_{\overline{\tau} \to 0^+} \underbrace{\frac{\mathbb{E}\left[\Delta \nu_{jt} | \tau_{jt} = 0\right] - \mathbb{E}\left[\Delta \nu_{jt} | 0 < \tau_{jt} \leq \overline{\tau}\right]}{\mathbb{E}\left[\Delta \ell_{jt} | \tau_{jt} = 0\right] - \mathbb{E}\left[\Delta \ell_{jt} | 0 < \tau_{jt} \leq \overline{\tau}\right]}}_{\text{winning due to amenity shock}}$$

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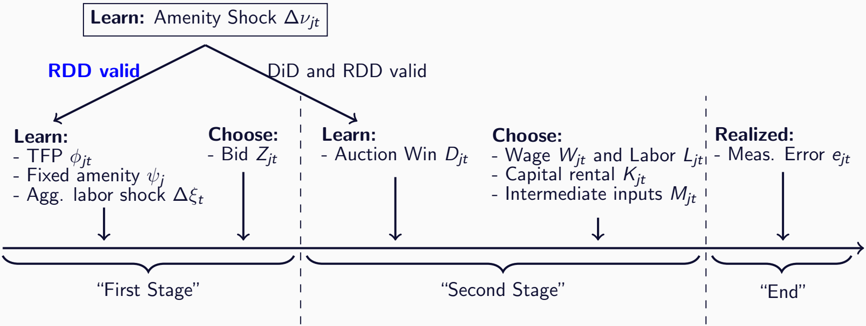
RDD Identification: $D_{jt} \perp \Delta \nu_{jt} | (Z_{jt}) \implies \lim_{\overline{\tau} \to 0^+} \theta_{RDD}(\overline{\tau}) = \theta$.

- First-price auctions $\implies$ winning fully determined by bids Z_{jt}.
- Thus, the assumption is always true in first-price auctions!
- Intuition: $\mathbb{E}[\Delta \nu]$ equal for winners & losers at discontinuity.

Sequence of Events within Time Period t



Labor Supply Elasticity (4/4)

Results using multiplicity of approaches:

- DiD Estimator: $1/\theta = 4.1$, markdown $= 0.80$
- RDD Estimator: $1/\theta = 3.5$, markdown $= 0.78$
- Estimator of Lamadon Mogstad Setzler (2022) panel-IV for full construction sample: $1/\theta = 4.0$, markdown $= 0.80$

Labor Supply Elasticity (4/4)

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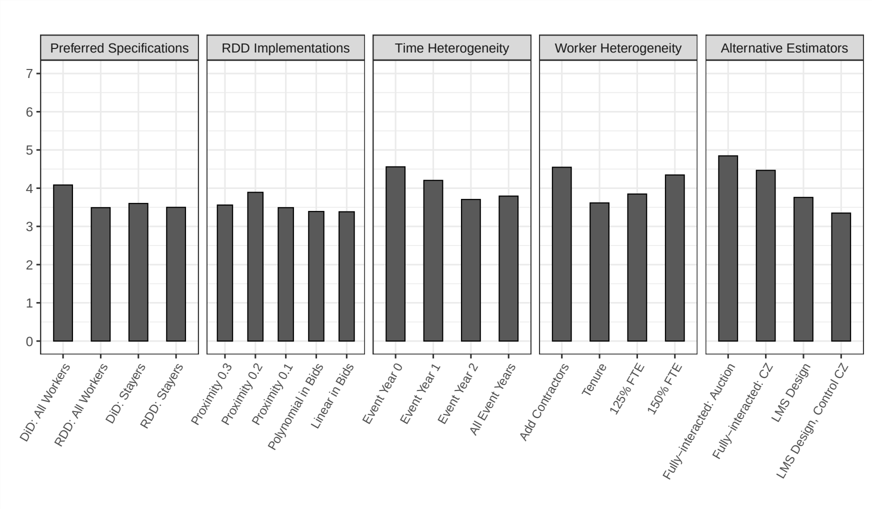
Sensitivity checks:

- Passes falsification test using DiD or RDD on the pre-period
- No evidence of bias from slow adjustments over time
- No evidence of bias from worker composition changes
- No evidence of bias from local aggregate shocks
- Not sensitive to alternative choices of auction loser sample
- Not sensitive to right-to-work or prevailing wage law coverage
- Not sensitive to alternative parameterizations of Proposition 2
- Various checks using this sample and external BLS and Census wage surveys indicate wage effects not due to hours responses
- ... ▸ more ▸ amenity

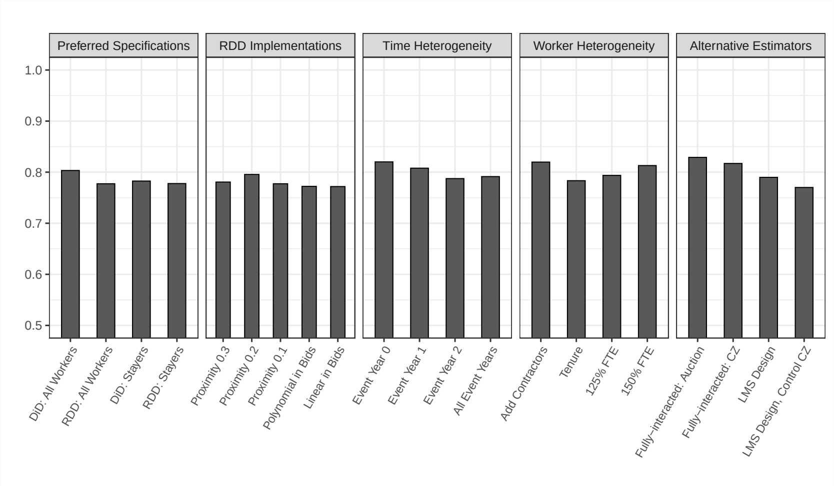
Robustness: Labor Supply Elasticity Specifications

Labor supply elasticity $1/\theta$:



Robustness: Wage Markdown Specifications

Wage markdown $(1+\theta)^{-1}$:



Technology and Product Demand Elasticities (1/2)

Goal: Identify the composite returns to labor, ρ.

Model: Optimal intermediate inputs imply,

$$x_{jt} = \kappa_X + \rho \ell_{jt} + \phi_{jt} \tag{18}$$

Challenge: log TFP ϕ is a determinant of both log labor ℓ and log intermediate input expenditures x.

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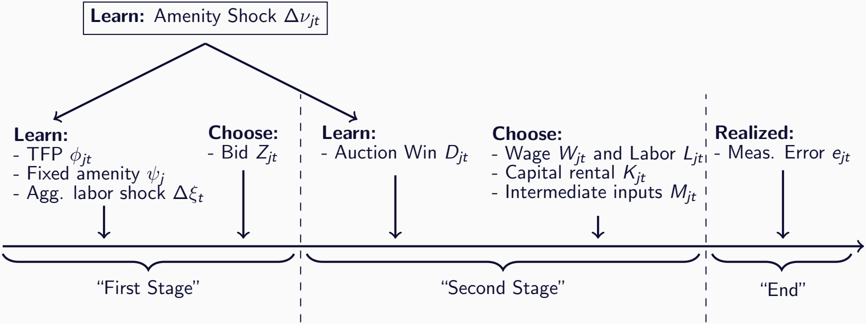
Identification: Controlling for (Z_{jt}, u_{jt}) controls for ϕ_{jt}:

$$\frac{\text{Cov}\left[x_{jt}, \ell_{jt} | \widehat{u}_{jt}, Z_{jt}\right]}{\text{Var}\left[\ell_{jt} | \widehat{u}_{jt}, Z_{jt}\right]} = \frac{\text{Cov}\left[x_{jt}, \ell_{jt} | \widehat{u}_{jt}, \phi_{jt}\right]}{\text{Var}\left[\ell_{jt} | \widehat{u}_{jt}, \phi_{jt}\right]} = \rho \tag{19}$$

Sequence of Events within Time Period t



Technology and Product Demand Elasticities (2/2)

Goal: Identify the product demand elasticity, $1/\epsilon$.

We extend the de Loecker Eeckhout Unger (2020) measure of inverse markups to incorporate labor market power ($\theta > 0$):

$$\overbrace{(1-\epsilon)}^{\text{markup}^{-1}} = \frac{\overbrace{(1+\theta)}^{\text{markdown}^{-1}}}{\beta_L} \frac{B_{jt}}{R_{jt}} + \frac{X_{jt}}{R_{jt}} = \overbrace{(1+\theta)}^{\text{markdown}^{-1}} \frac{s_L}{\beta_L} + s_M \tag{20}$$

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Product demand elasticity: We estimate $1/\epsilon = 7.3$, which gives a **price markup**, $1/(1-\epsilon)$, that is 16% above marginal cost.

Composite returns to labor: We estimate $\rho = 1.09$, just above **constant returns to scale**, in line with the literature (e.g. Combes Duranton & Gobillon 2021 find CRS in housing construction).

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- Robust to using main identifying moments instead of GMM.
- Robust to Cobb-Douglas instead of Leontief prod function.
- Robust to relaxing the auction symmetry assumption.
- Robust to controlling for aggregate price shocks.

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Estimates: Double Markdown

$$W_{jt} = \overbrace{(1+\theta)^{-1}}^{\text{markdown}} \times \text{MRPL}_{jt}$$

A natural measure of monopsony power is the **markdown**

- We estimate a **markdown** of 0.80, so workers are paid 20% below the marginal revenue product of labor (MRPL)

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But MRPL depends on **product market power**

- Special case w/o intermediate inputs: MRPL equals **inverse markup** times the value of the marginal product of labor (MPL) at fixed prices, so **higher markup** $\implies$ **lower wage**

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- Special case w/o intermediate inputs: MRPL equals **inverse markup** times the value of the marginal product of labor (MPL) at fixed prices, so **higher markup** $\implies$ **lower wage**

We estimate a **double markdown** of 0.69.

- Workers are paid 31% below the value of their MPL
- If we ignored the markup, we would think workers are paid 20% below the value of their MPL

Estimates: Double Markup

$$P_{jt} = \overbrace{(1 - \epsilon)^{-1}}^{\textbf{markup}} \times \frac{\mathsf{MCL}_{jt}}{\mathsf{MPL}_{jt}}$$

A natural measure of monopoly power is the **markup**

- We estimate a **markup** of 1.16, so prices are 16% above the productivity-adjusted marginal cost of labor.

Estimates: Double Markup

$$P_{jt} = \overbrace{(1-\epsilon)^{-1}}^{\text{markup}} \times \frac{\text{MCL}_{jt}}{\text{MPL}_{jt}} = \underbrace{\overbrace{(1-\epsilon)^{-1}}^{\text{markup}} \times \overbrace{(1+\theta)}^{\text{inverse markdown}}}_{\text{double markup}} \times \frac{W_{jt}}{\underbrace{\text{MPL}_{jt}}_{\text{prod.-adjusted wage}}}$$

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- We estimate a **markup** of 1.16, so prices are 16% above the productivity-adjusted marginal cost of labor.

But MCL depends on **labor market power**

- Stronger **markdown** $\implies$ Higher **price**

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A natural measure of monopoly power is the **markup**

- We estimate a **markup** of 1.16, so prices are 16% above the productivity-adjusted marginal cost of labor.

But MCL depends on **labor market power**

- Stronger **markdown** $\Longrightarrow$ Higher **price**

We estimate a **double markup** of 1.44.

- Prices are 44% above the effective average cost
- If we ignored the markdown, we would think prices are 16% above the value of the effective average cost

Summary: Estimates of Double Market Power

Panel A.	Components of the Double Markdown of the Wage		
	Markdown $(1+\theta)^{-1}$	Inverse Markup $(1-\epsilon)$	Double Markdown $(1+\theta)^{-1}(1-\epsilon)$
Using θ_{DiD}:	0.803	0.863	0.693
Using θ_{RDD}:	0.777		0.671
Panel B.	**Components of the Double Markup of the Price**		
	Markup $(1-\epsilon)^{-1}$	Inverse Markdown $(1+\theta)$	Double Markup $(1-\epsilon)^{-1}(1+\theta)$
Using θ_{DiD}:	1.159	1.245	1.443
Using θ_{RDD}:		1.286	1.491

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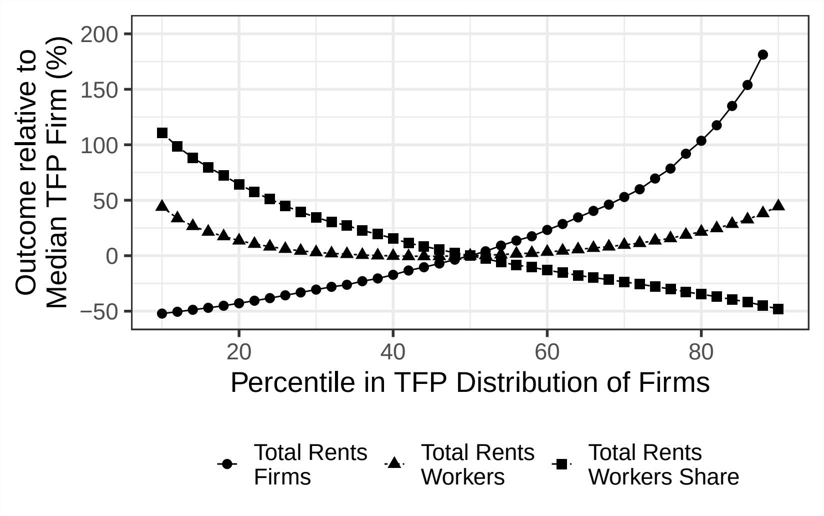
Estimates of Baseline Rents

		Actual	Counterf.	Difference	
		$d = 1$	$d = 0$	Level	Relative
Labor market					
L_{jt}	Employment (#)	**24.7**	12.8	11.9	92.7%
W_{jt}	Wage (\$1K)	**59.1**	50.4	8.8	17.4%
B_{jt}	Wage bill (\$1K)	**1,459.6**	645.2	814.4	126.2%
Rents					
V_{jt}	Worker rents (\$1K/L)	**11.6**	5.1	6.5	126.2%
π_{jt}	Firm profits (\$1K/L)	**43.1**	33.4	9.6	28.7%

In the actual economy ($d = 1$), per-capita worker rents $\frac{W}{1+1/\theta}$ are about \$12,000 per year, less than 1/4 of all rents.

Estimates of Rents and TFP



Workers' share of rents is smaller at more productive firms.

Estimates of Marginal Rents from Procurements

		Actual	Counterf.	Difference	
		$d = 1$	$d = 0$	Level	Relative
Labor market					
L_{jt}	Employment (#)	24.7	12.8	11.9	92.7%
W_{jt}	Wage ($1K)	59.1	50.4	8.8	17.4%
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π_{jt}	**Firm profits ($1K/$L$)**	**43.1**	**33.4**	**9.6**	**28.7%**

We simulate winning versus losing an auction among winners.

Hiring to fulfill the government contract leads to bidding up wages, running up worker rents, with only a small increase in firm rents.

Estimates of Crowd-out from Procurements

		Actual	Counterf.	Difference	
		$d = 1$	$d = 0$	Level	Relative
Input Expenditures					
B_{jt}	Wage bill ($1K)	1,459.6	645.2	814.4	126.2%
X_{jt}	Intermediate inputs ($1K)	4,715.1	2,308.6	2,406.5	104.2%
$p_K K_{jt}$	Capital rentals ($1K)	1,724.7	762.4	962.3	126.2%
Total production					
Q_{jt}	Output (#)	38.3	18.7	19.5	**104.2%**
R_{jt}	Revenue ($1K)	8,962.1	4,541.6	4,420.5	**97.3%**
Private production					
Q^H_{jt}	Output (#)	13.7	18.7	-5.1	**-27.0%**
R^H_{jt}	Revenue ($1K)	3,460.7	4,541.6	-1,080.9	**-23.8%**

The government contract nearly doubles the firm's revenues.

However, it crowds out about 1/4 of private sector output.

Note that output declines more than revenues due to markups.

Outline

1. Framework with Labor and Product Market Power
2. Double Market Power
3. Data Sources
4. Recovering Key Model Parameters
5. Estimates of Double Market Power
6. Estimates of Rents and Incidence
7. **Counterfactual Labor and Product Market Power**

Theory: Impacts of Labor Market Power (1/3)

Effect of interest: Increase labor market power, all else equal.

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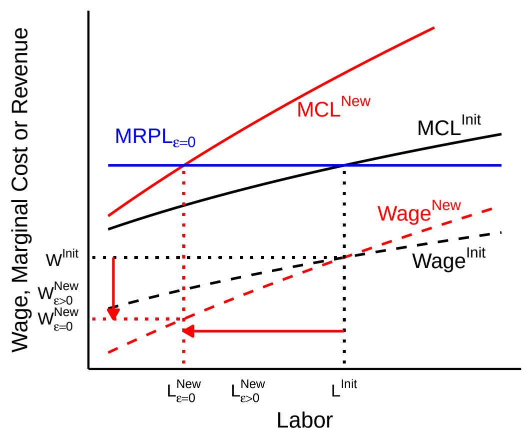
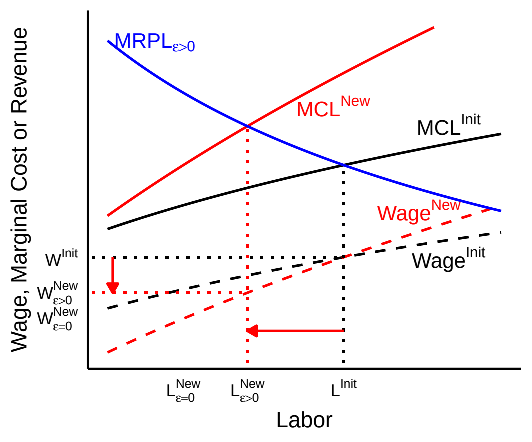
Solution: When increasing θ, also adjust the amenity (U_{jt}) so that the initial (labor, wage) combination is still on the labor supply curve. Analogous to Slutsky compensation, removes the level shift.

Theory: Impacts of Labor Market Power (2/3)



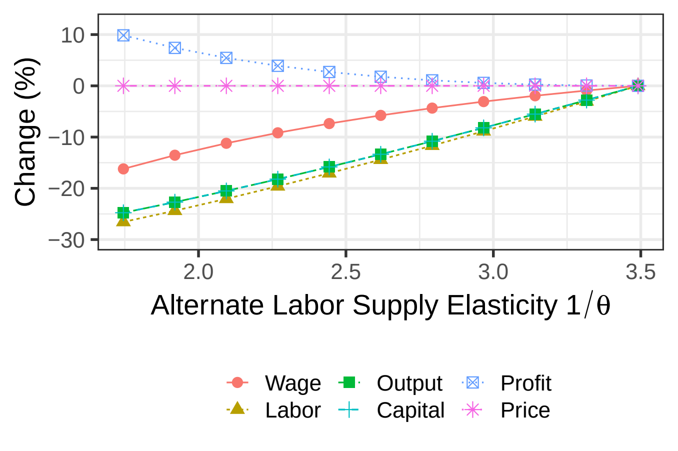
- No price-setting power $\implies$ flat MRPL curve
- More labor market power $\implies$ steeper MCL (red) $\implies$ less employment, greater wage markdown

Theory: Impacts of Labor Market Power (3/3)



- Firm has price-setting power $\implies$ downward-sloping MRPL
- Cut employment $\implies$ cut output $\implies$ higher output price $\implies$ incentive not to cut employment as much

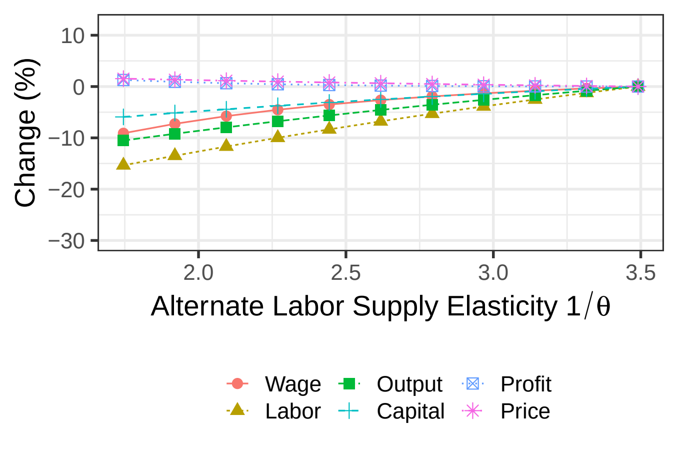
Model Simulation: Impacts of Labor Market Power (1/2)



Consider reducing LS elasticity $1/\theta$ in half

- Simulate from estimated model, counterfactually set $\epsilon = 0$
- Employment $\downarrow$ 27%, wages $\downarrow$ 16%, profits $\uparrow$ 10%

Model Simulation: Impacts of Labor Market Power (2/2)



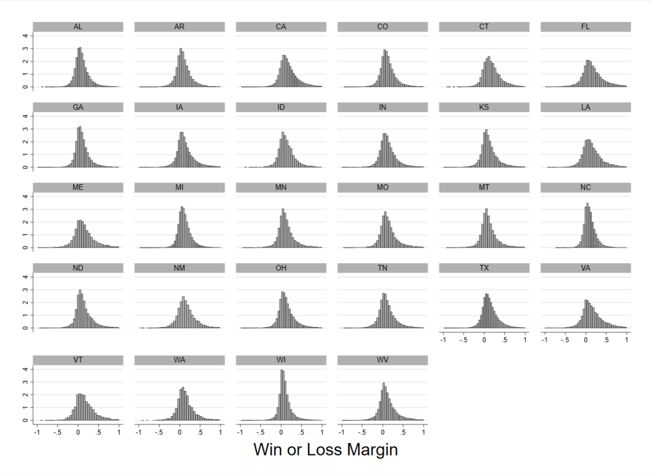
- Simulate from estimated model, use estimated $1/\epsilon = 7.3$
- Employment $\downarrow$ 15%, wages $\downarrow$ 9%, profits $\uparrow$ 1% $\implies$ impacts of labor market power mitigated by product market power

Conclusions

- Developed a framework for jointly analyzing **labor** and **product** market power
- Leveraged features of **procurement auctions** to recover **labor supply**, **technology**, and **product demand**
- We estimate a markdown on MRPL of 20%. Furthermore, we find a **double markdown** on value of MPL of 31%, due to **product** market power
- Firms capture more than 3/4 of rents, high productivity firms share less, but workers capture a high share of marginal rents
- Simulations from estimated model show that impacts of **labor** market power depend on degree of **product** market power

Appendix

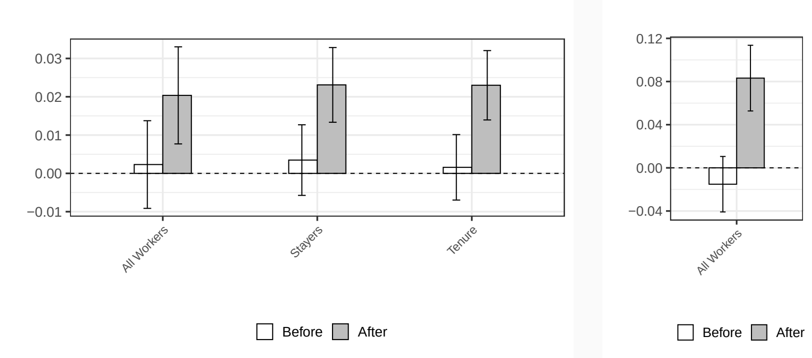
Visual test of collusion from Chassang et al (2022)



None of our 28 states has a "missing mass" of close losing bids. Chassang Kawai Nakabayashi Ortner (2022 ECMA) show that such patterns should be found broadly under collusive behavior.

Falsification using Pre-period

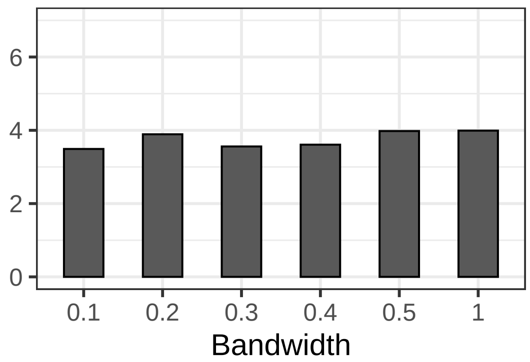
Effects on wages (left) and employment (right):



Back

Bandwidths in the RDD estimator

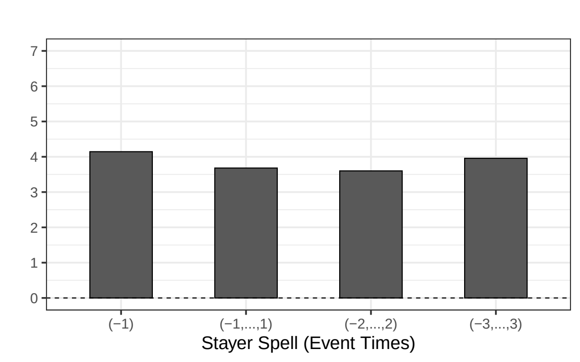
Labor supply elasticity for alternative bandwidths ($\bar{\tau}$):



Back

Stayers and Tenure Samples (1/2)

Labor supply elasticity by stayer spell:



Back

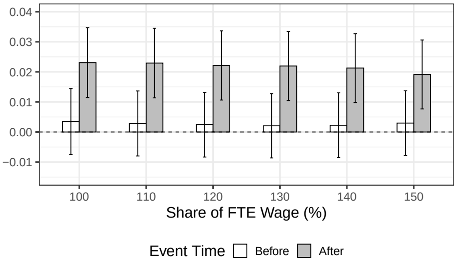
Stayers and Tenure Samples (2/2)

Labor supply elasticity by tenure length:

◂ Back

Hours and full-time status (1/2)

Labor supply elasticity by FTE threshold (as % of min. wage):



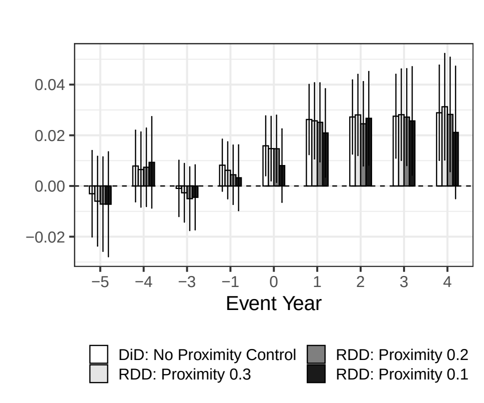
Other notes:

- US construction industry during 2001-2015 was 4.6% part-time labor vs 13.9% in entire private sector (BLS)
- LMS estimator in Norway: revenue shock pass-through of 0.092 (annual earnings) and 0.091 (hourly wages)

◂ Back

Hours and full-time status (2/2)

Wage effects persist over time (inconsistent with over-time pay):



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Prevailing Wage: Restricting the Sample of Firms

	All States		Prevailing Wage States	
	All Workers	Stayers	All Workers	Stayers
Impacts of Winning an Auction:				
Log Employment:	0.083		0.081	
	(0.019)		(0.023)	
Log Earnings per Worker:	0.020	0.023	0.023	0.027
	(0.008)	(0.006)	(0.010)	(0.007)
Implied Labor Parameters:				
Labor Supply Elasticity:	4.084	3.600	3.508	3.054
Markdown relative to MRPL:	0.803	0.783	0.778	0.753

Back

Prevailing Wage: Effects of Davis-Bacon Repeals

Total Compensation (log)	Wage Compensation (log)	Non-wage Fringe Benefits (log)	Share Non-wage Fringe Benefits (fraction)
Difference-in-Differences for State Davis-Bacon Repeals			
0.009	0.009	0.015	0.000
(0.026)	(0.029)	(0.031)	(0.005)

Back

Sources of Compensation in the Construction Industry

◂ Back

OSHA Investigations and Violations

	OSHA Investigations		OSHA Violations	
	Probability	Count	Probability	Count
	Occurrence			
Observed Average:	0.075	0.139	0.041	0.110
	Impacts of Winning a Procurement Auction			
Impact: Before Treatment	0.000	-0.012	0.000	-0.009
	(0.006)	(0.016)	(0.004)	(0.018)
Impact: After Treatment	0.009	0.004	0.000	-0.006
	(0.008)	(0.020)	(0.006)	(0.023)

Back

Measurement Error Orthogonality

The goal is to estimate $1-\epsilon$ using the relationship:

$$r_{jt} = \kappa_R + (1-\epsilon)\, x_{jt} + (1-\epsilon)\, e_{jt}$$

where e_{jt} is the error in the relationship between log revenues r_{jt} and log intermediates x_{jt}. The key identifying restriction is,

$$\text{Cov}(x_{jt}, e_{jt}) = 0$$

This orthogonality condition is satisfied under the assumption by Ackerberg et al. (2015) that the firm has no information about e_{jt} at the time inputs are chosen:

> *"The [e_{jt}] represent shocks to production or productivity that are* **not observable (or predictable)** *by firms before making their input decisions at t... [e_{jt}] can also represent (potentially serially correlated) measurement error in the output variable." Ackerberg et al. (2015, ECMA)*

Indeed, x_{jt} should be uncorrelated with e_{jt} if e_{jt} is completely unpredictable at the time x_{jt} is chosen. Back

Composite Production Function

As far as we know, ours is the first paper with three distinct types of imperfectly competitive markets:

- Input market for **workers**
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- Government market for **procurements**

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- We do not observe capital. By assuming capital is competitive with rental price p_K, it can be substituted out of the firm's problem. This assumption is especially realistic in construction, which has a massive equipment rental industry.
- We do not observe quantity vs price of materials. Materials are assumed to be competitive with price p_M. This assumption is especially realistic for construction, e.g., road inputs like lime and asphalt are not differentiated.

Given these assumptions and the Ackerberg et al. (2015) production function, the firm's cost-minimization can be rearranged to show that $\rho = (1+\theta)\beta_K + \beta_L$ is the composite returns to labor. Back

Compensation with Endogenous Amenity Creation (1/2)

Alternative Framework: Suppose the firm can create amenities to offer workers. Let Comp_{jt} denote the total compensation offered by the firm (inclusive of wages and amenities).

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Compensation Elasticity: If we observed Comp_{jt}, we could infer the (inverse) labor supply elasticity with respect compensation:

$$\widetilde{\theta} = \frac{\mathbb{E}\left[\Delta \log \text{Comp}_{jt} | \tau_{jt} = 0\right] - \mathbb{E}\left[\Delta \log \text{Comp}_{jt} | 0 < \tau_{jt} \leq \overline{\tau}\right]}{\mathbb{E}\left[\Delta \ell_{jt} | \tau_{jt} = 0\right] - \mathbb{E}\left[\Delta \ell_{jt} | 0 < \tau_{jt} \leq \overline{\tau}\right]}$$

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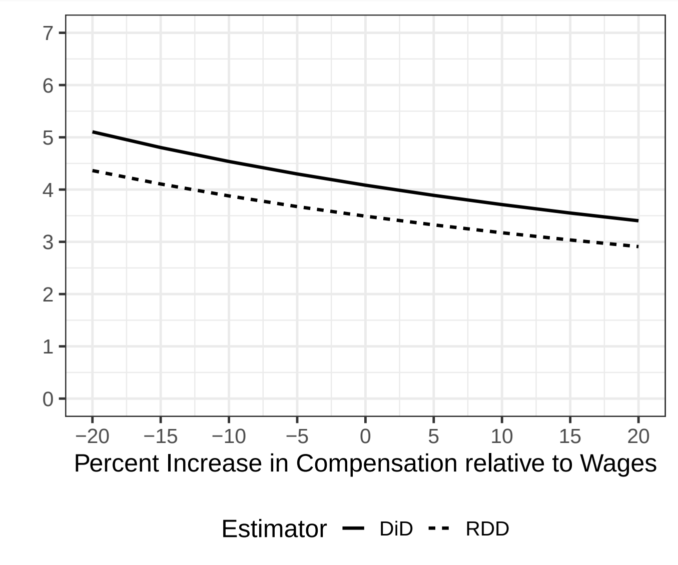
Calibration: In practice, however, we only observe wages W_{jt}, so we use $\Delta \log W_{jt}$ in place of $\Delta \log \text{Comp}_{jt}$. It is useful to define

$$\lambda \equiv \frac{\mathbb{E}\left[\Delta \log \text{Comp}_{jt} | \tau_{jt} = 0\right] - \mathbb{E}\left[\Delta \log \text{Comp}_{jt} | 0 < \tau_{jt} \leq \overline{\tau}\right]}{\mathbb{E}\left[\Delta \log W_{jt} | \tau_{jt} = 0\right] - \mathbb{E}\left[\Delta \log W_{jt} | 0 < \tau_{jt} \leq \overline{\tau}\right]} - 1$$

$\lambda \times 100\%$ is the percent increase in log compensation relative to log wages. In the following figure, we calibrate $\lambda \times 100\%$ and examine how our conclusions would change if winning a procurement auction had a causal effect on amenity provision.

Compensation with Endogenous Amenity Creation (2/2)



Elasticity estimates remain in our preferred 3-5 range. Back