

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

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- **Product market:** firms may markup prices above MC.
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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.
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- **Approach:** Leverage institutional features of the **auction** to isolate an observable firm-specific labor demand shock.
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**Identify returns to labor and product demand elasticities:**

- **Challenge:** 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:

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- **Double markdown:** MRPL depends on price **markups**.  
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- **Theoretical finding:** impacts of **labor market power** are attenuated by existence of **product market power**.
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- **Quantitative finding:** Reducing labor supply elasticity in half,
  - if the firm were a **price-taker**: 22% less employment
  - with **product market power**: 12% 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

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. Data Sources
3. Recovering Key Model Parameters
4. Results from Estimated Model
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# Model

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

The model serves several purposes:

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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



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

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

- $g_{jt}$  is common, gives rise to *vertical* differentiation
- $\eta_{ijt}$  is idiosyncratic to worker  $i$ , gives *horizontal* differentiation
- Parameterize  $\eta_{ijt}$  as T1EV with dispersion  $\theta$
- Information asymmetry: firms don't see  $\eta_{ijt}$  for a given worker

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**Firm-specific labor supply curve:**

$$W_{jt} = L_{jt}^{\theta} U_{jt} \quad \implies \quad w_{jt} = \theta \ell_{jt} + u_{jt} \quad (2)$$

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 Akerberg et al (2015) technology,

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

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**Composite Production** If capital market is perfect, simplifies to

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

where  $\rho$  is composite labor returns and  $\Phi_{jt}$  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,

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

# 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  $D_j = d$ ,

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

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



# Government Market for Procurements

**Opportunity Cost** Given private market profits  $\pi_{djt}^H$  if  $D_{jt} = d$ ,

$$\sigma_u(\phi_{jt}) = \pi_{0jt}^H - \pi_{1jt}^H > 0, \quad (8)$$

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

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

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**Optimal bid** Unique symmetric equilibrium is defined by,

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

where  $l$  is number of bidders and  $\delta$  is markup on opportunity cost

# Defining Worker Rents

**Notation** Suppose firm  $j$  increases wage from  $W_{jt}$  to  $\widetilde{W}_{jt}$ , and denote worker  $i$ 's preferred firm excluding  $j$  as  $j_t^*$

**Worker Rents** The equivalent variation  $V_{ijt}$  for the wage change is

$$\underbrace{\max \left\{ \begin{array}{l} \log \widetilde{W}_{jt} + g_{jt} + \eta_{ijt}, \\ \log W_{j_t^* t} + g_{j_t^* t} + \eta_{ij_t^* t} \end{array} \right\}}_{\text{utility with wage increase at firm } j} = \underbrace{\max \left\{ \begin{array}{l} \log (W_{jt} + V_{ijt}) + g_{jt} + \eta_{ijt}, \\ \log (W_{j_t^* t} + V_{ijt}) + g_{j_t^* t} + \eta_{ij_t^* t} \end{array} \right\}}_{\text{equivalent utility at the initial choice of firm}}$$

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**Sum of Worker Rents** Using our functional form to simplify,

$$V_{jt} \equiv \sum_i V_{ijt} = \frac{\widetilde{B}_{jt} - B_{jt}}{1 + 1/\theta} \quad (10)$$

where  $\widetilde{B}_{jt} - B_{jt}$  is the change in wage bill and  $1/\theta$  is LS elasticity

# Rents and Incidence

## Incidence of Procurements

$$\underbrace{V_{1jt}}_{\text{Total rents}} = \underbrace{V_{0jt}}_{\text{Baseline rents}} + \underbrace{V_{\Delta jt}}_{\text{Incidence}} = \underbrace{\frac{B_{0jt}}{1 + 1/\theta}}_{\text{Baseline rents}} + \underbrace{\frac{B_{1jt} - B_{0jt}}{1 + 1/\theta}}_{\text{Incidence}} \quad (11)$$

## Incidence for Incumbents and New Hires

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## Firm Rents

$$\underbrace{\pi_{1jt}}_{\text{Total firm rents}} = \underbrace{\pi_{0jt}}_{\text{Baseline firm rents}} + \underbrace{\pi_{\Delta jt}}_{\text{Incidence on firms}} \quad (12)$$

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2. Data Sources
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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
- No evidence of collusion [▶ test results](#)

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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<br>(\$ 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

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# 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 (5 slides)
- **Firm technology** & **product demand** elasticities (4 slides)

# Labor Supply Elasticity (1/5)

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

**Model:** Log inverse labor supply curve is,

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**Easy to deal with:**

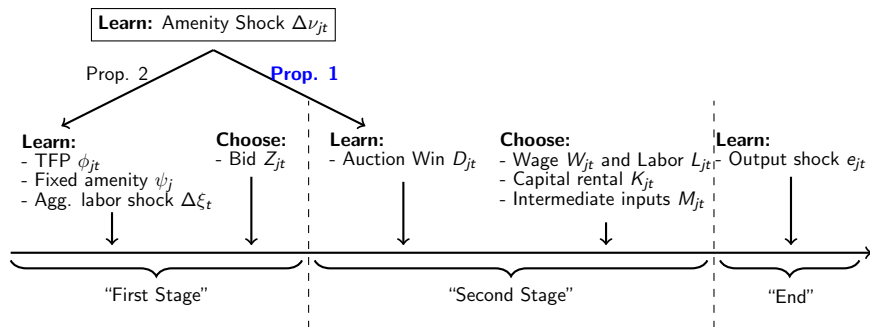
- Time-invariant firm-specific amenities  $\psi_j$  (take differences)
- Aggregate labor supply shocks  $\Delta \xi_t$  (add year fixed effects)

$$\Delta w_{jt} = \theta \Delta \ell_{jt} + \Delta \xi_t + \Delta \nu_{jt} \quad (14)$$

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



# Sequence of Events within Time Period $t$



## Labor Supply Elasticity (2/5)

**Assumption 1.**  $\Delta\nu_{jt}$  not in information set at “First Stage” of  $t$  when bid is placed in auction  $\implies D_{jt} \perp \nu_{jt} | (\psi_j, \xi_t)$ .

- Time delay assumptions are standard for identification in empirical IO (Akerberg et al 2015; Gandhi et al 2020).
- Delay is between *estimating* labor cost (bidding at beginning of period  $t$ ) and actually hiring labor (middle of period  $t$ )

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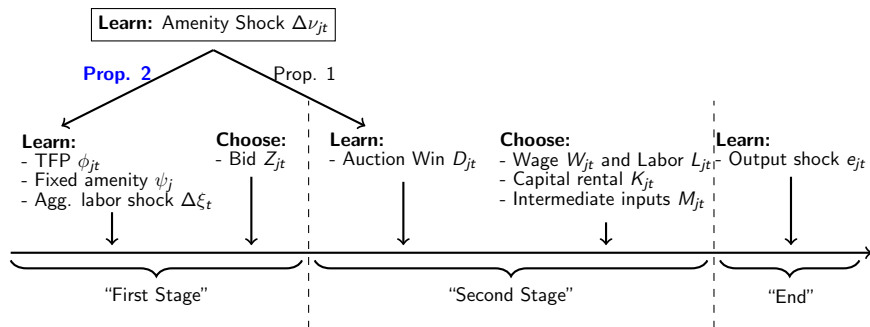
**Proposition 1.**  $\theta$  is recovered by the IV estimator,

$$\theta_{IV} \equiv \frac{\text{Cov}[\Delta w_{jt}, D_{jt}]}{\text{Cov}[\Delta \ell_{jt}, D_{jt}]} \quad (15)$$

Important to emphasize what is **not** restricted by Assumption 1:

- 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 (3/5)

**Alternative:** Leverage auction structure to relax Assumption 1.

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**Loss margin:** For a firm  $j$  that bids in auction  $\iota$  at time  $t$ , define  $\tau_{jt} \equiv \frac{Z_{jt} - Z_{\iota}^*}{Z_{\iota}^*}$ , where  $Z_{\iota}^*$  is the winning bid in auction  $\iota$ .

# Labor Supply Elasticity (3/5)

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**Loss margin:** For a firm  $j$  that bids in auction  $\iota$  at time  $t$ , define  $\tau_{jt} \equiv \frac{Z_{jt} - Z_{\iota}^*}{Z_{\iota}^*}$ , where  $Z_{\iota}^*$  is the winning bid in auction  $\iota$ .

**Intuition:**

- First-price auctions  $\implies$  winning fully determined by bids  $Z_{jt}$ .
- Restrict sample to  $\tau_{jt} \leq \bar{\tau}$ . As  $\bar{\tau} \rightarrow 0^+$ ,  $Z_{jt}$  of winners=losers.
- Therefore,  $\mathbb{E}[\Delta \nu_{jt}]$  of winners and losers converges as  $\bar{\tau} \rightarrow 0^+$

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**Proposition 2:** Define an IV estimator of the form,

$$\theta_{\bar{\tau}} \equiv \frac{\mathbb{E}[\Delta w_{jt} | \tau_{jt} = 0] - \mathbb{E}[\Delta w_{jt} | 0 < \tau_{jt} \leq \bar{\tau}]}{\mathbb{E}[\Delta \ell_{jt} | \tau_{jt} = 0] - \mathbb{E}[\Delta \ell_{jt} | 0 < \tau_{jt} \leq \bar{\tau}]} \quad (16)$$

where  $\bar{\tau}$  is a proximity parameter and the conditioning on  $\iota$  is implicit. Then,  $\lim_{\bar{\tau} \rightarrow 0^+} \theta_{\bar{\tau}} = \theta$ .



# Labor Supply Elasticity (4/5)

## Results using multiplicity of approaches:

- Estimator of Proposition 1:  $1/\theta = 4.1$ , markdown = 0.80
- Estimator of Proposition 2:  $1/\theta = 3.5$ , 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 (4/5)

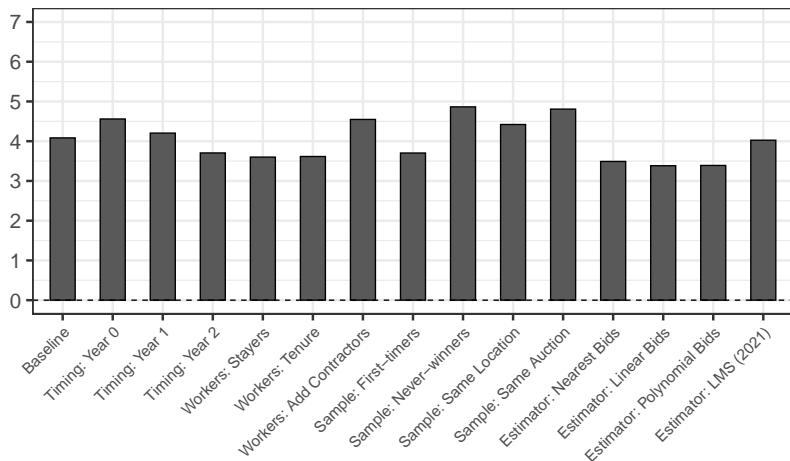
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## Sensitivity checks:

- Passes falsification test using IV on the pre-period outcomes
- 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](#)

# Labor Supply Elasticity (5/5)



# Technology and Product Demand Elasticities (1/4)

**Goal:** Identify the composite returns to labor,  $\rho$ .

**Model:** Optimal intermediate inputs imply,

$$x_{jt} = \kappa_X + \rho \ell_{jt} + \phi_{jt} \quad (17)$$

**Challenge:** log TFP  $\phi$  is a determinant of both log labor  $\ell$  and log intermediate input expenditures  $x$ .

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**Proposition 4:** Controlling for  $(Z_{jt}, u_{jt})$  controls for  $\phi_{jt}$ :

$$\frac{\text{Cov}[x_{jt}, \ell_{jt} | \hat{u}_{jt}, Z_{jt}]}{\text{Var}[\ell_{jt} | \hat{u}_{jt}, Z_{jt}]} = \frac{\text{Cov}[x_{jt}, \ell_{jt} | \hat{u}_{jt}, \phi_{jt}]}{\text{Var}[\ell_{jt} | \hat{u}_{jt}, \phi_{jt}]} = \rho \quad (18)$$

## Technology and Product Demand Elasticities (2/4)

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

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However, output quantity  $Q_{jt}^H$  is not observed in our data.



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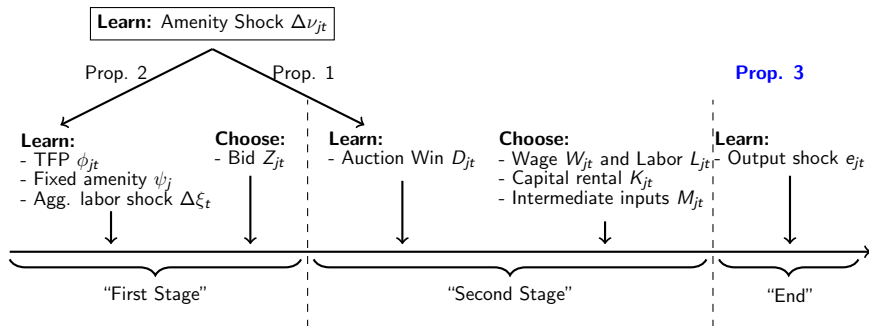
$$r_{jt} = \kappa_R + (1-\epsilon) x_{jt} + (1-\epsilon) e_{jt} \quad \text{if } D_{jt} = 0 \quad (20)$$

**Timing of information:** [Akerberg et al \(2015\)](#) restriction that  $x$  is chosen before output shock  $e$  is realized (timeline on next slide)

**Proposition 3:**

$$e_{jt} \perp x_{jt} \implies \frac{\text{Cov}[r_{jt}, x_{jt} | D_{jt} = 0]}{\text{Var}[x_{jt} | D_{jt} = 0]} = 1 - \epsilon \quad (21)$$

# Sequence of Events within Time Period $t$



## Technology and Product Demand Elasticities (3/4)

Two additional identifying moments:

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

$$\overbrace{(1 - \epsilon)}^{\text{markup}^{-1}} = \frac{\overbrace{(1 + \theta)}^{\text{markdown}^{-1}}}{\beta_L} \frac{B_{jt}}{R_{jt}} + \frac{X_{jt}}{R_{jt}} \quad (22)$$

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- First-order condition for auction winners: for any candidate parameters  $(\epsilon, \rho, \theta)$ , we can construct the left-hand and right-hand sides of the winner's FOC wrt labor:

$$\Lambda_{jt} = \kappa_\Lambda + \rho \ell_{jt} + \phi_{jt} + e_{jt} \quad \text{if } D_{jt} = 1. \quad (23)$$

where we can construct log TFP  $\phi_{jt} = x_{jt} - \rho \ell_{jt}$  for any candidate  $\rho$  and  $\Lambda$  is a term we can construct.

**Over-identification:** We combine these two moments with the key identifying moments for  $\epsilon$  and  $\rho$  above, then estimate these 4 equations in 3 unknowns using GMM.

# Technology and Product Demand Elasticities (4/4)

| Baseline Estimates using Over-identified GMM       |                |       |         |  |
|--|----------------|-------|---------|--|
|  | Parameters     | Data  |         |  |
| Private demand parameter                           | $1 - \epsilon$ | 0.863 | (0.015) |  |
| Composite labor scale parameter                    | $\rho$         | 1.089 | (0.017) |  |
| Returns to labor parameter                         | $\beta_L$      | 0.499 | (0.192) |  |
| Alternative Estimates using Exactly-identified OLS |                |       |         |  |
|  | Parameters     | Data  |         |  |
| Diminishing returns to output                      | $1 - \epsilon$ | 0.863 | (0.008) |  |
| Optimal intermediate inputs                        | $\rho$         | 1.057 | (0.015) |  |
| Labor to value added ratio                         | $\beta_L$      | 0.514 | (0.209) |  |

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

**Composite returns to labor:** We estimate  $\rho = 1.09$ , just above **constant returns to scale** (like Levinsohn and Petrin 2003).

# Technology and Product Demand Elasticities (4/4)

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**Composite returns to labor:** We estimate  $\rho = 1.09$ , just above **constant returns to scale** (like Levinsohn and Petrin 2003).

- 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.

# Outline

1. Framework with Labor and Product Market Power
2. Data Sources
3. Recovering Key Model Parameters
4. Results from Estimated Model
5. Interactions between Labor and Product Market Power



## Results from Estimated Model (1/5): Double Markdown

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

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)

## Results from Estimated Model (1/5): Double Markdown

$$W_{jt} = \overbrace{\frac{1}{1+\theta}}^{\text{markdown}} \times \text{MRPL}_{jt} = \underbrace{\overbrace{\frac{\theta}{1+\theta}}^{\text{markdown}} \times \overbrace{\left(\frac{1/\epsilon}{1/\epsilon - 1}\right)^{-1}}^{\text{inverse markup}}}_{\text{composite markdown}} \times \underbrace{P_{jt} \times \text{MPL}_{jt}}_{\text{VMPL}}$$

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

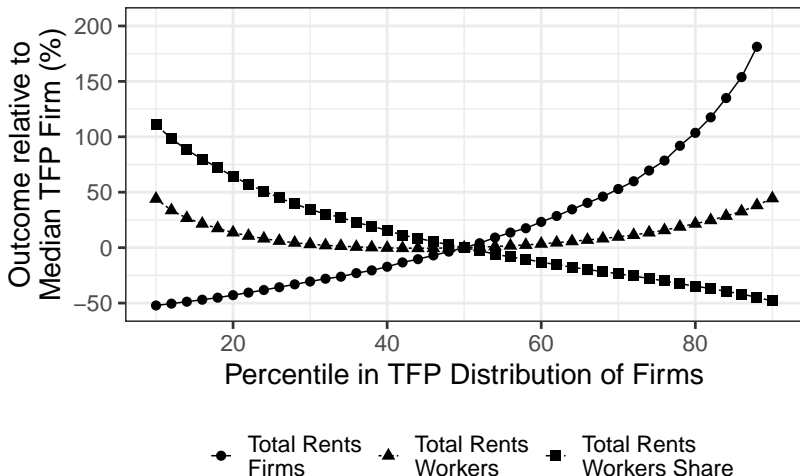
- We estimate a **markdown** of 0.80, so workers are paid 20% below the marginal revenue product of labor (MRPL)
- But MRPL depends on **product market power**
- Special case w/o intermediate inputs: MRPL equals **inverse markup** times the value of the marginal product of labor (MPL) at fixed prices, so **higher markup**  $\Rightarrow$  **lower wage**
- We estimate a **composite markdown** of 0.69, so workers are paid 31% below VMPL, versus 20% if ignoring the markup

# Results from Estimated Model (2/5): Baseline Rents

|                     |                           | Actual  | Counterf. | Difference |          |
|---------------------|---------------------------|---------|-----------|------------|----------|
|                     |                           | $d = 1$ | $d = 0$   | Level      | Relative |
| <b>Labor market</b> |                           |         |           |            |          |
| $L_{jt}$            | 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%   |
| <b>Rents</b>        |                           |         |           |            |          |
| $V_{jt}$            | Worker rents (\$1K/ $L$ ) | 11.6    | 5.1       | 6.5        | 126.2%   |
| $\pi_{jt}$          | 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.

## Results from Estimated Model (3/5): Rents and TFP



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

# Results from Estimated Model (4/5): Marginal Rents

|                     |                              | Actual      | Counterf.   | Difference |               |
|---------------------|------------------------------|-------------|-------------|------------|---------------|
|                     |                              | $d = 1$     | $d = 0$     | Level      | Relative      |
| <b>Labor market</b> |                              |             |             |            |               |
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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.

# Results from Estimated Model (5/5): Output/Crowd-out

|                           |                            | Actual  | Counterf. | Difference |               |
|---------------------------|----------------------------|---------|-----------|------------|---------------|
|                           |                            | $d = 1$ | $d = 0$   | Level      | Relative      |
| <b>Input Expenditures</b> |                            |         |           |            |               |
| $B_{jt}$                  | 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%        |
| <b>Total production</b>   |                            |         |           |            |               |
| $Q_{jt}$                  | Output (#)                 | 38.3    | 18.7      | 19.5       | <b>104.2%</b> |
| $R_{jt}$                  | Revenue (\$1K)             | 8,962.1 | 4,541.6   | 4,420.5    | <b>97.3%</b>  |
| <b>Private production</b> |                            |         |           |            |               |
| $Q_{jt}^H$                | Output (#)                 | 13.7    | 18.7      | -5.1       | <b>-27.0%</b> |
| $R_{jt}^H$                | Revenue (\$1K)             | 3,460.7 | 4,541.6   | -1,080.9   | <b>-23.8%</b> |

The government contract nearly doubles the firm's revenues.

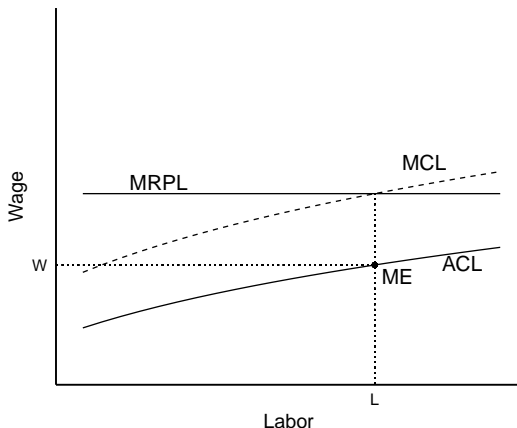
However, it crowds out about 1/4 of private sector output.

Note that output declines more than revenues due to markups.

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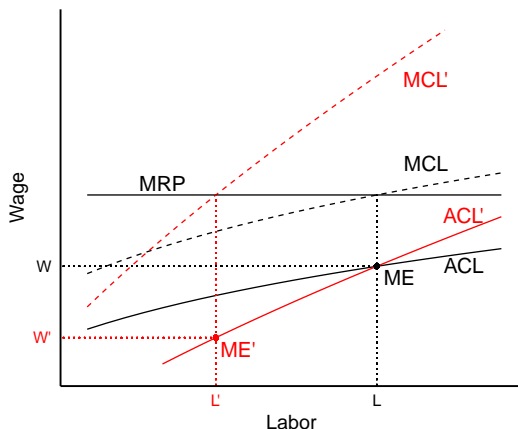
# Theory: Impacts of Labor Market Power (1/3)



- No price-setting power  $\implies$  flat MRPL curve
- Labor market power: upward-sloping MCL
  - Firm chooses L such that  $MRPL = MCL$ ,  $W < MRPL$

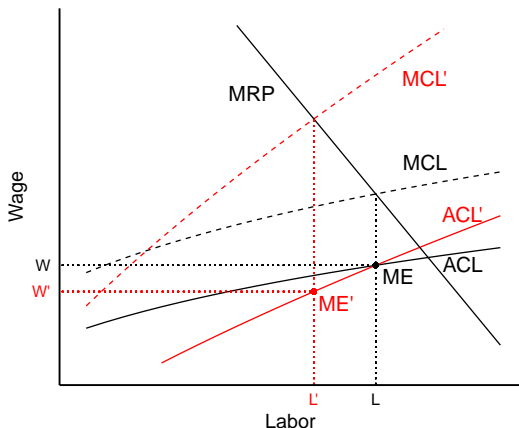


## Theory: Impacts of Labor Market Power (2/3)



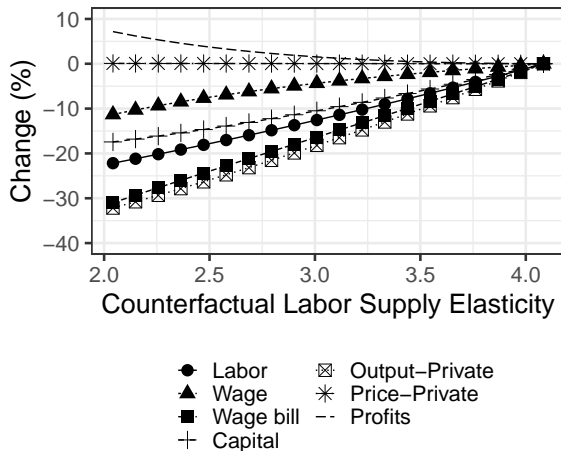
- No price-setting power  $\Rightarrow$  flat MRPL curve
- More labor market power  $\Rightarrow$  steeper MCL (red)  
 $\Rightarrow$  less employment, greater wage markdown

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



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

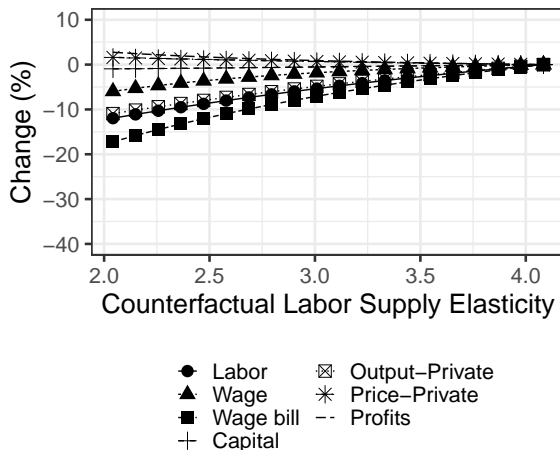
# Model Simulation: Impacts of Labor Market Power (1/2)



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

- Simulate from estimated model, counterfactually set  $\epsilon = 0$
- Employment  $\downarrow$  22%, wages  $\downarrow$  11%, profits  $\uparrow$  7%

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



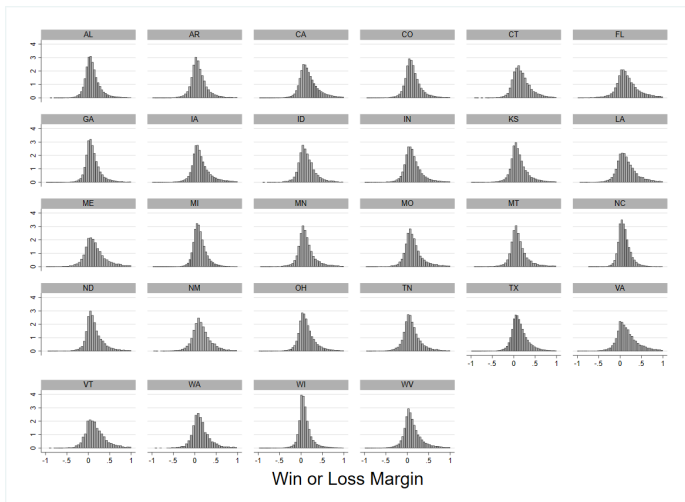
- Simulate from estimated model, use estimated  $1/\epsilon = 7.3$
- Employment  $\downarrow$  12%, wages  $\downarrow$  6%, profits  $\uparrow$  3%  $\implies$  impacts of labor market power mitigated by product market power

# 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**
- While the usual markdown is only 20%, we found a **double wage markdown** 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

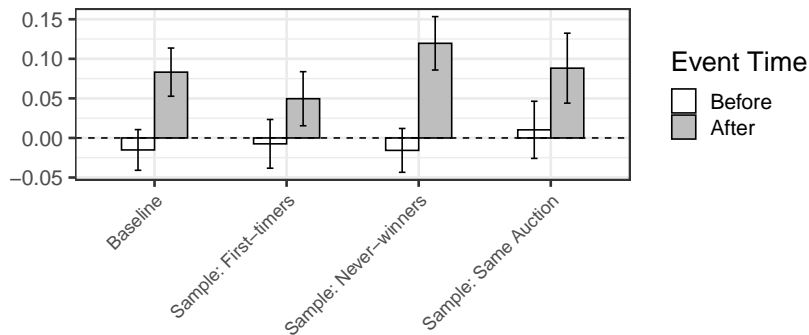
## Visual test of collusion from Chassang et al (2022)



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 (1/2)

Effects on employment:

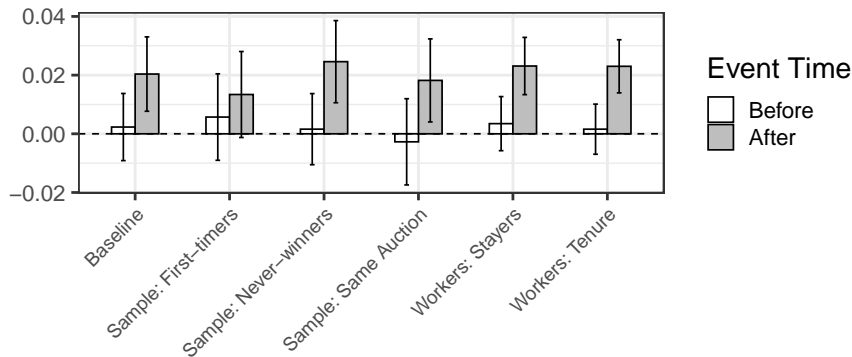


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# Falsification using Pre-period (2/2)

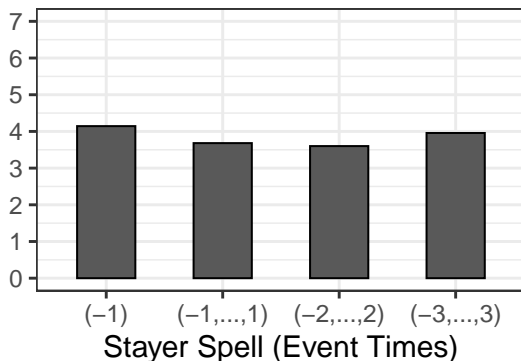
Effects on wages:



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# Stayers and Tenure Samples (1/2)

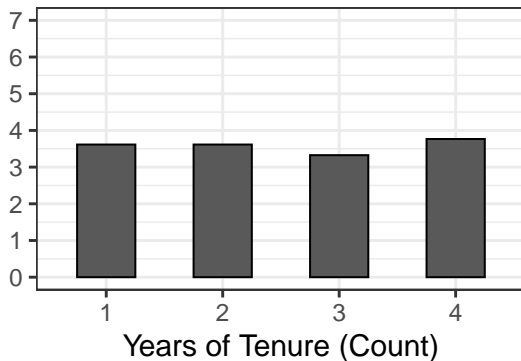
Labor supply elasticity by stayer spell:



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## Stayers and Tenure Samples (2/2)

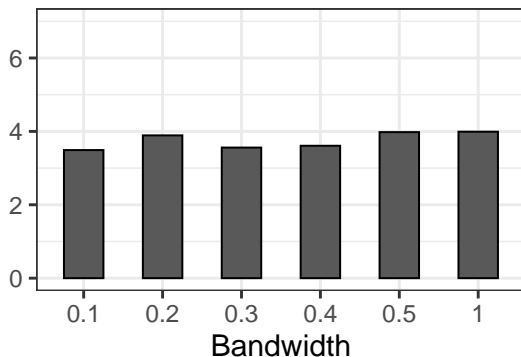
Labor supply elasticity by tenure length:



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## Bandwidths in the Prop 2 estimator (1/1)

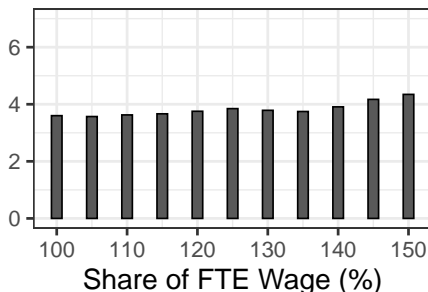
Labor supply elasticity for alternative bandwidths ( $\bar{\tau}$ ):



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## Hours and full-time status (1/2)

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



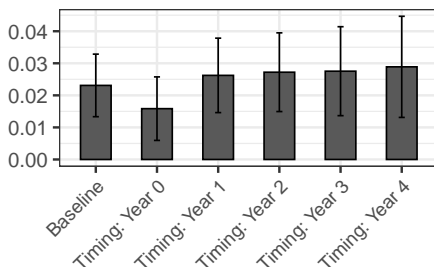
Other notes:

- 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)

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## Hours and full-time status (2/2)

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



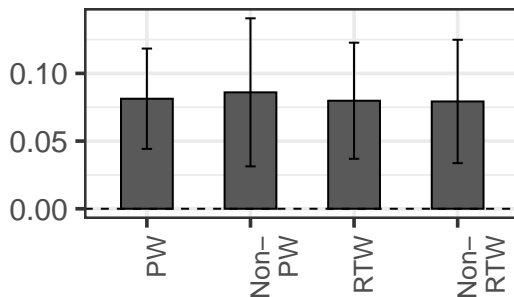
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# Right-to-Work and Prevailing Wage States (1/2)

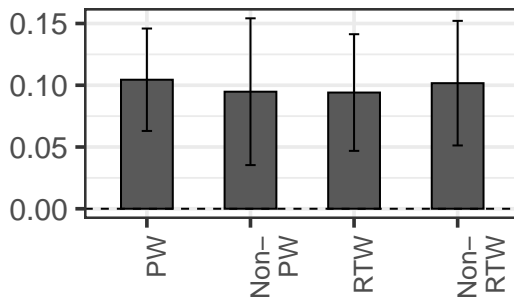
Effects on employment:



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# Right-to-Work and Prevailing Wage States (2/2)

Effects on wage bill:



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## 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,

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

This orthogonality condition is satisfied under the assumption by Akerberg 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.” Akerberg 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.