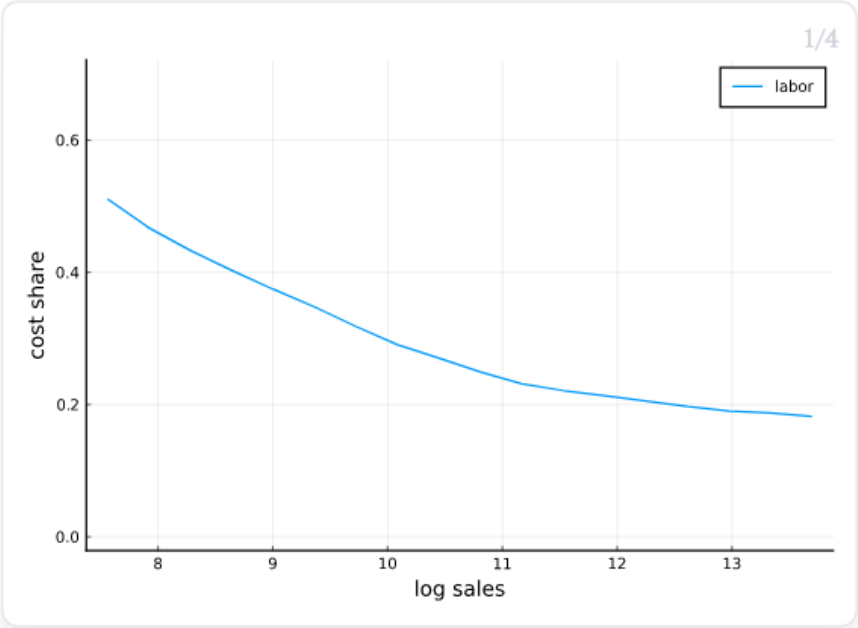


Why Do Larger Firms Have Lower Labor Shares?

L. Henry de Frahan, T. Lamadon, T. Meling, and M. Mogstad

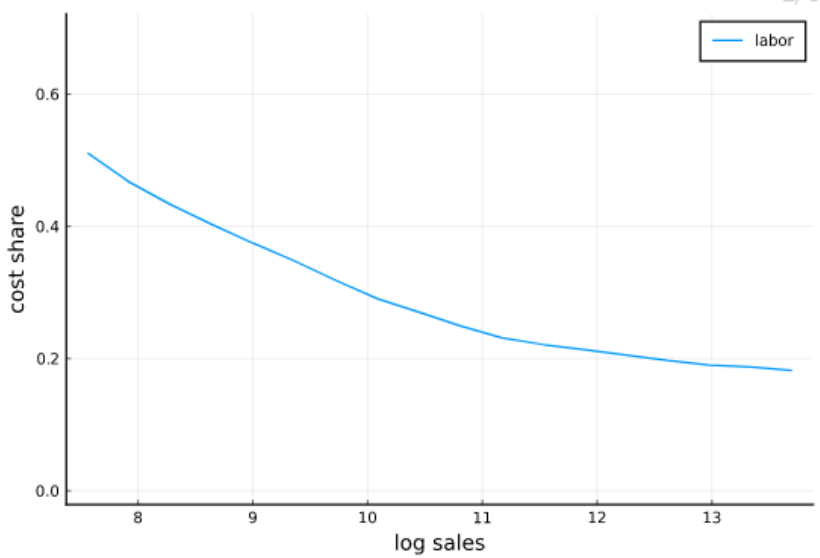
Motivation

- In the cross-section of firms in many countries (including the U.S.)
  - wage bill as a share of total cost is decreasing in sales
  - wage bill as a share of sales (or value added) is decreasing in sales
- In Norwegian data more



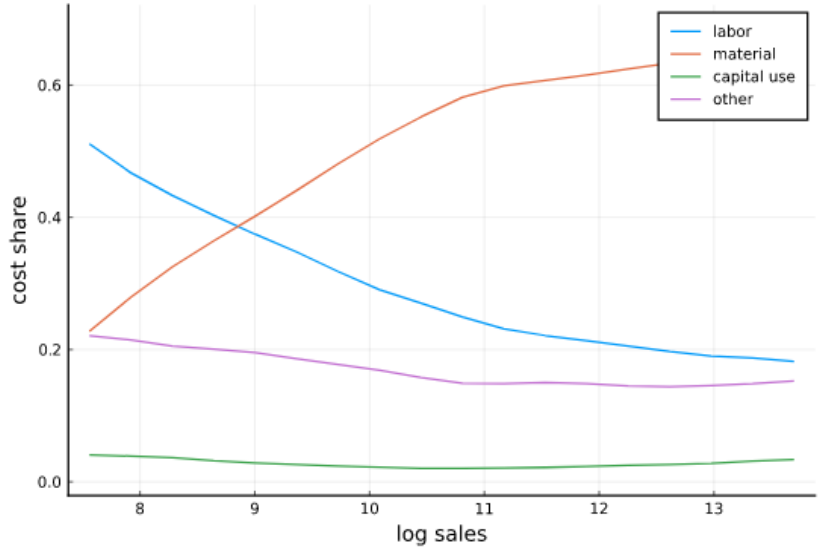
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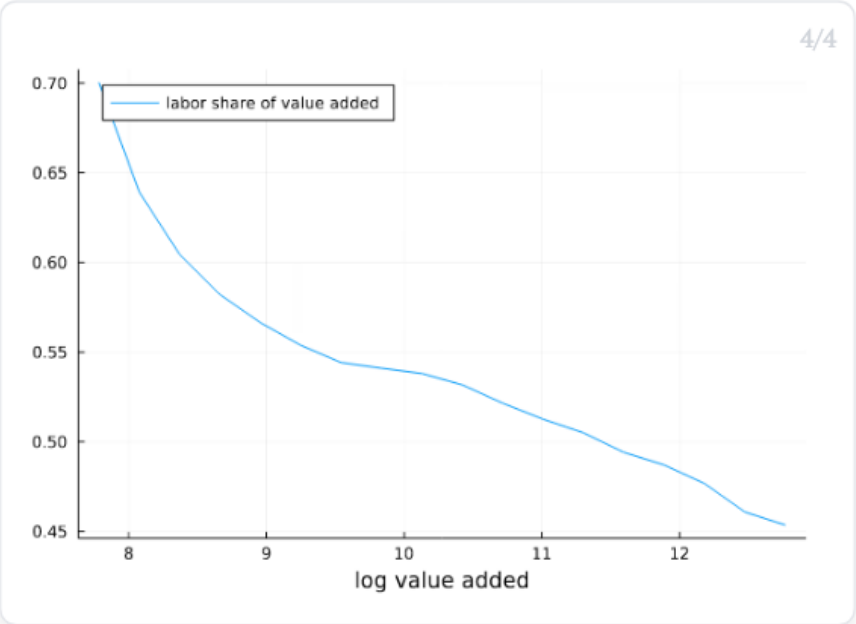
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Channels we study

1. Upward-sloping labor supply curves
   - labor units become more expensive with employment size
   - labor supply becomes more inelastic, wage markdowns get larger
2. Within-firm scale effects in production
   - input elasticity of revenue increases (e.g. increasing product market markups)
   - substitution effect: relative marginal revenue of labor decreases
3. Fixed firm heterogeneity that correlates with TFP
   - production heterogeneity (e.g. automation)
   - labor costs (e.g. amenities)

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> Importantly, different channels have different efficiency and policy implications.

Our approach

A model of heterogeneous monopsonic firms with

- a non-homothetic revenue function with multiple inputs
- upward-sloping labor supply curves with varying elasticity
- unobserved heterogeneity in TFP, production, and labor cost

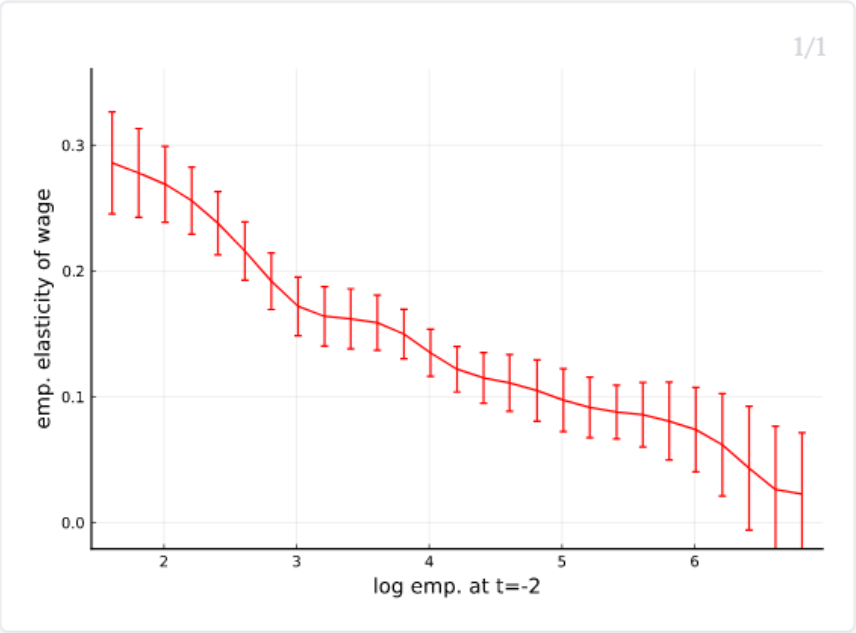
Properties and identification of the model

- express primitives as functions of elasticities in response to TFP (or product demand) shocks
- elasticities conditional on size allow for semi-parametric identification and estimation

Panel data on the universe of Norwegian firms

- rely on firm earnings statements (revenue, intermediate inputs, ...) and individual worker earnings
- use panel to run analysis within firm and worker
- use IV to isolate productivity shocks
  - internal IV: panel data restrictions
  - external IV: procurement auction wins

Preview of main findings



1. Employment elasticity of wages decreases as firms get larger
2. Labor faced by large firm looks more or less like a competitive market

Literature

- Karabarbounis and Neiman (2019); Kehrig and Vincent (2021); Autor et al. (2020); Grossman and Oberfield (2021)
- Lamadon, Mogstad and Setzler (2021); Kroft, Luo, Mogstad and Setzler (2021); Berger, Herkenhoff and Mongey (2021); Jarosch, Nimczik and Sorkin (2021)
- Acemoglu and Restrepo (2020); Hubmer and Restrepo (2021); Edmond, Midrigan and Xu (2021); Bilal and Lhuillier (2021); Baqaee and Farhi (2018)
- Hall (1988); De Loecker and Warzynski (2012); De Loecker, Eeckhout and Unger (2020); Chen, Macaluso and Hershbein (2021)

This talk

1. Model of the firm

2. Model implied elasticities and identification

3. Data and empirical approach

4. Results
   - labor supply curves (main focus today)
   - production function

5. Take-away and conclusion

Input factors

Firms are indexed by j and use 2 input factors
Consider firm j in isolation

1. Labor input L with cost

$$\delta_j C(L)$$

   - $C(\cdot)$ allows for flexible upward-sloping curves
   - δ_j allows for firm-specific intercept (e.g. amenities)
   - $\delta_j C(L)$ can be supported by a Kimball preference aggregator for workers

$$\max_L \int W_j L \ \text{ s.t } \ \int \delta_j \Gamma\left(\frac{L}{L_0}\right) dj = 1$$

2. Other inputs V treated as expenditure (constant marginal cost)

Revenue function

$$Y_j(A, L, V) = A \cdot F\Big(\omega_j H(L) + (1 - \omega_j) G(V)\Big)$$

- A is firm TFP
- L and V are labor and other inputs
- ω_j allows for firm-specific heterogeneity (e.g. better average labor quality)

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Properties

- nests CES and Cobb-Douglas production functions
- $H(\cdot)$ and $G(\cdot)$ allow for different returns to L and V
- $F(\cdot)$ allows for flexible input elasticity of revenue
- elasticity of substitution can vary with revenue
- additional inputs can be included (we currently focus on materials)

Firm problem

- Firms maximize profits

$$\Pi_j(A) = \max_{L,V} Y_j(A, V, L) - \delta_j C(L) - V$$

- Curvature in $C(L)$
  - taken into account when choosing L
  - allows for monopsony power
  - can vary with size
- Revenue function reflects
  - product market power
  - returns to scale in production

Parameters of interest

- Common functions $C(\cdot), G(\cdot), H(\cdot), F(\cdot)$
- Firm-specific parameters δ_j, ω_j, A_j
- Counterfactuals
  - within-firm causal effect of changing A_j
  - decomposition of cross-sectional relationship between Y, L, V

Identification overview

- Ideal experiment: access to firm-specific shock to TFP A
- Using model structure, identify primitives from elasticities of observed quantities in three steps

1. ΔL and ΔW at each L
   - $\rightarrow$ trace out labor supply curve $C(\cdot)$
   - $\rightarrow$ levels pin down δ_j
2. ΔL and ΔV at each (L, V)
   - $\rightarrow$ give $H(\cdot)$ and $G(\cdot)$
   - $\rightarrow$ levels pin down ω_j
3. ΔY and $\Delta \Pi$ at each composite input level
   - $\rightarrow$ give $F(\cdot)$
   - $\rightarrow$ levels pin down A_j

Step 1: Labor supply curve

- Firm j hires labor on its labor supply curve

$$\delta_j C(L_j) = W_j \cdot L_j$$

- Given a shock to A keeping $\delta_j C(\cdot)$ fixed, we get

$$\frac{\partial \log C(L_j)}{\partial \log L} = 1 + \frac{d \log W_j}{d \log L_j} = 1 + \varepsilon_{W,L}(L_j)$$

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  - Conditional on L_j the elasticity does not depend on j
  - Recovering such elasticity for each L_j identifies $C(\cdot)$
  - $C(\cdot)$, wage bill and L_j pin down δ_j for each firm

Step 2: Input functions

- The ratio of FOCs gives

$$\frac{\omega_j}{1-\omega_j}\frac{H'(L_j)}{G'(V_j)} = \delta_j C'(L_j)$$

- The log change due to a shock to A implies

$$\frac{\partial \log H'(L_j)}{\partial \log L} - \varepsilon_{V,L}(V_j, L_j)\frac{\partial \log G'(V_j)}{\partial \log V} = \frac{\partial \log C'(L_j)}{\partial \log L}$$

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- Conditional on L_j and V_j the elasticity does not depend on j
- Under some additional restrictions, this identifies $H(\cdot)$ and $G(\cdot)$
- Given $H(\cdot), V(\cdot)$ and $C(\cdot)$ we identify ω_j from L_j, V_j

Step 3: Revenue function

- Denote composite input

$$S_j = \omega_j H(L_j) + (1 - \omega_j) G(V_j)$$

- The firm problem satisfies

$$\frac{d \log Y_j}{d \log S_j} - \frac{\Pi_j}{Y_j} \frac{d \log \Pi_j}{d \log S_j} = \frac{\partial \log F(S_j)}{\partial \log S}$$

- Conditional on S_j, the LHS does not depend on j
- This identifies $F(\cdot)$ and A_j

Identification overview again

1. ΔL and ΔW at each L
   - $\rightarrow$ trace out labor supply curve $C(\cdot)$
   - $\rightarrow$ levels pin down δ_j
2. ΔL and ΔV at each (L, V)
   - $\rightarrow$ give $H(\cdot)$ and $G(\cdot)$
   - $\rightarrow$ levels pin down ω_j
3. ΔY and $\Delta \Pi$ at each composite input level
   - $\rightarrow$ give $F(\cdot)$
   - $\rightarrow$ levels pin down A_j

Norwegian data

Firm accounting data (1999-2018)

- all incorporated firms (main sample: 43k firms)
- full earnings statement (revenue, wage bill, material cost, depreciation and amortization, and other operating costs)

Worker data (1999-2018)

- all employment relationships (main sample: 4.5m workers)
- wage payments, hours worked, occupation, industry, and other demographics

Procurement data (2003-2019)

- scraped from Doffin.no, a website announcing government procurement contract wins in Norway
- winning firm, contract size, product type, and contract location
- standard name matching algorithm to link winner names to firm tax IDs
- 5k unique first-time winners in our sample

Empirical strategy

- We use the panel dimension to control for firm heterogeneity
- To get $\varepsilon_{W,L}(L)$, we rely on the first order expansion around τ_0

$$\begin{aligned}\log W_{jt} &= \log W_{j\tau_0} + \log \delta_{jt} + \frac{\partial \log \tilde{W}(L_{j\tau_0})}{\partial \log L}(\log L_{it} - \log L_{j\tau_0}) + \epsilon_{jt} \\ &= \alpha_j + \lambda_t + \varepsilon_{W,L}(L_{j\tau_0}) \cdot \log L_{jt} + \epsilon_{jt}\end{aligned}$$

  - $W_{jt} = \delta_{jt}\tilde{W}(L_{jt}) \equiv \delta_{jt}C(L_{jt})/L_{jt}$
  - amenity term has a time-specific market component $\delta_{jt} = \delta_j \cdot \delta_{m(j),t}$
- A valid instrument Λ_{jt} conditional on size $L_{i\tau_0}$ requires

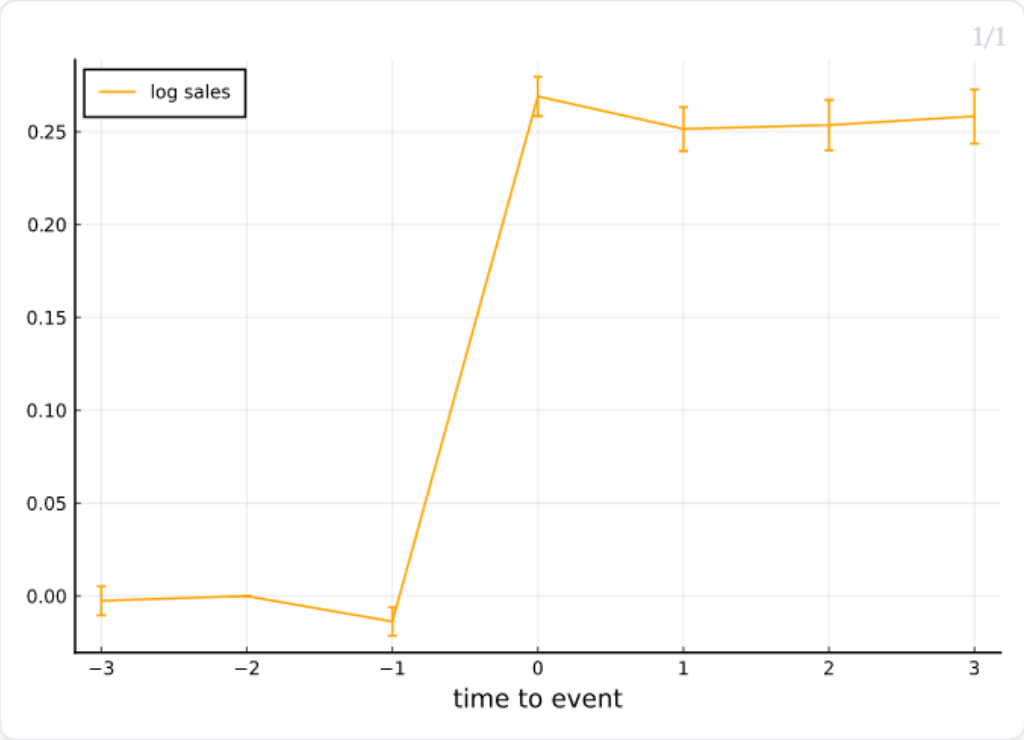
$$\mathbb{E}[\Lambda_{jt}\epsilon_{it}|L_{j\tau_0}, \alpha_j, \lambda_t] = 0,\ \mathbb{E}[\Lambda_{jt}\log L_{it}|L_{j\tau_0}, \alpha_j, \lambda_t] \neq 0$$

Internal instrument

- We instrument long-run changes in L_{jt} with short-run changes in Y_{jt} under the assumptions that
  - TFP is a unit-root process ▸ details
  - $\omega_j, \delta_j, C, H, G, G$ remain fixed
  - transitory errors in different variables are independent
- We run the analysis within cohorts of firms around a year t_0
  - $\Lambda_j = \mathbf{1}\{\Delta Y_{jt_0} > m\}$ where m is median sales growth in the market at t_0
  - L_{jt} is total employment
  - W_{jt} is the wage of stayers with full-year employment
  - include market-time-cohort FE and firm-cohort FE
  - we condition on L_{j,t_0-2} (i.e. $\tau_0 = t_0 - 2$) using a Gaussian kernel

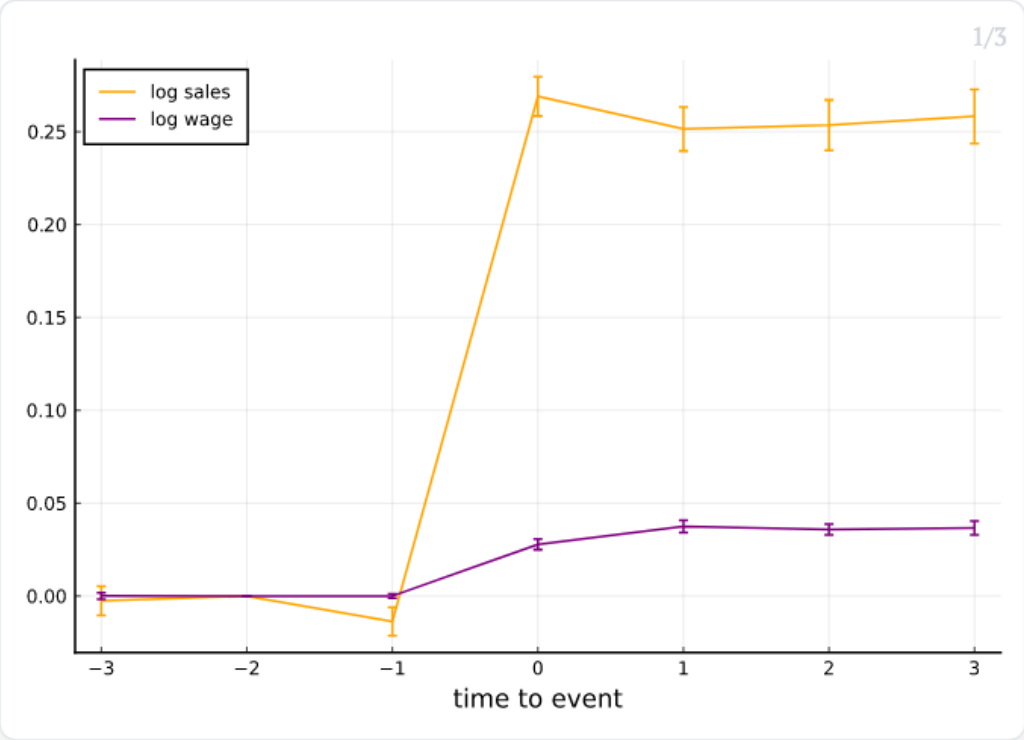
- The rank condition can be tested with the first stage
- Overidentification can be tested with pre-trends

Effect on sales - unconditional



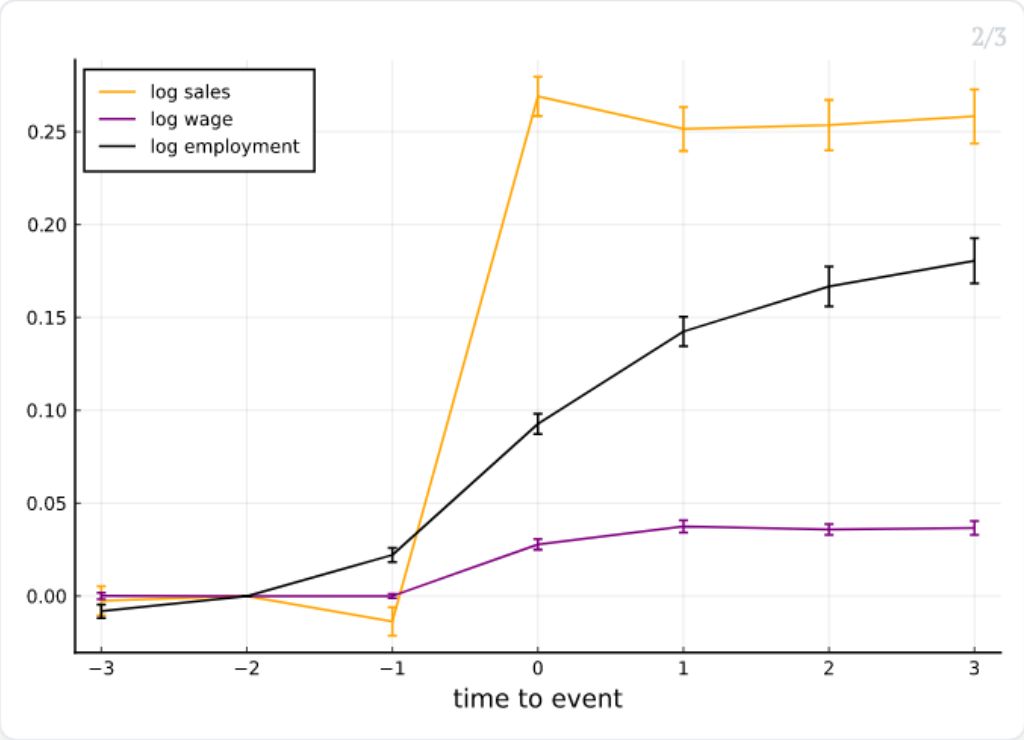
- Treatment assignment uses change between -1 and 0
- no apparent anticipation
- shock appears permanent

First stage and reduced form - unconditional



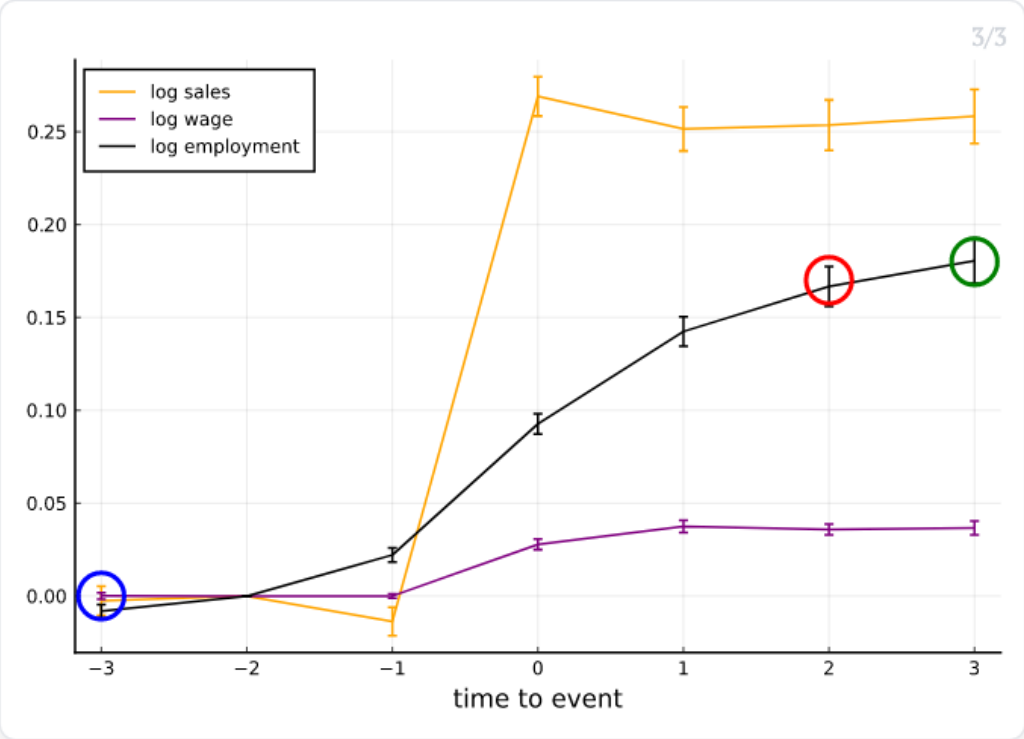
- We compare $t{=}{-}2$ to $t{=}2, 3$ for the effect of the shock ✅
- We compare $t{=}{-}2$ to $t{=}{-}3$ for the pre-trend ✅

First stage and reduced form - unconditional



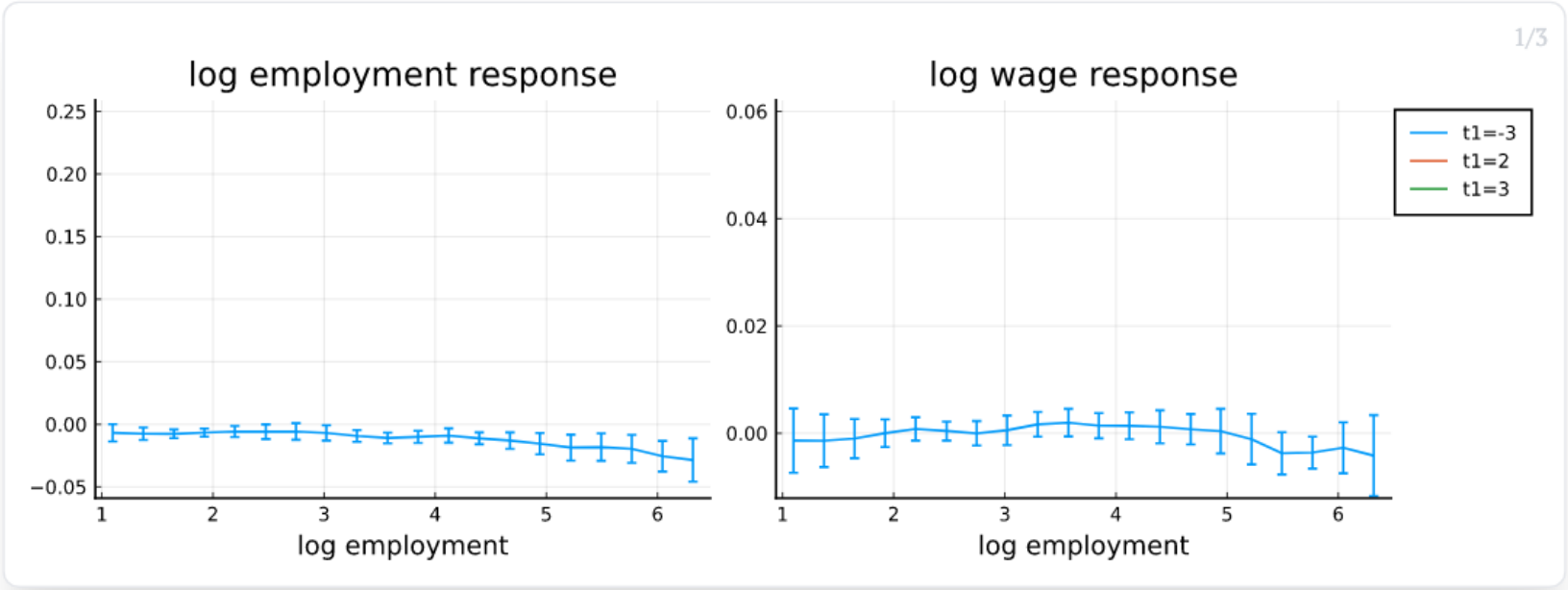
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First stage and reduced form - unconditional



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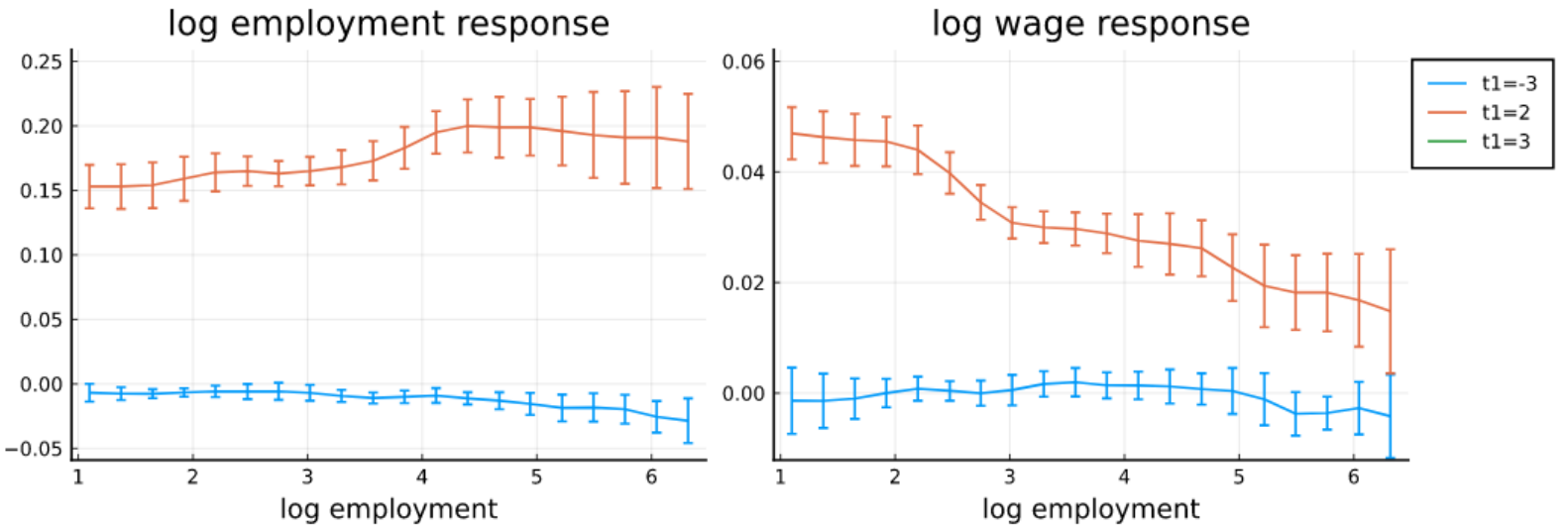
First stage and reduced form - conditional on size



- Employment response doesn't change much with firm size
- Wage response decreases as firms get larger
- All first stage regressions are strong

Sales Distr.

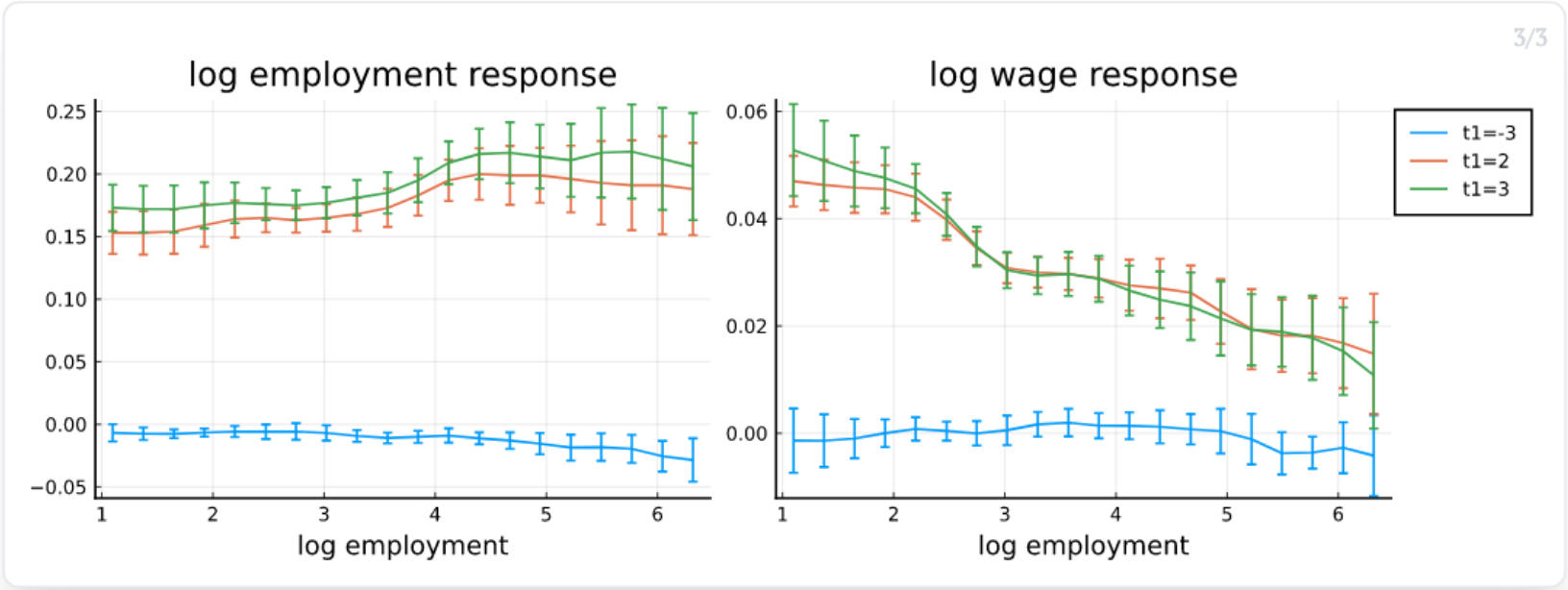
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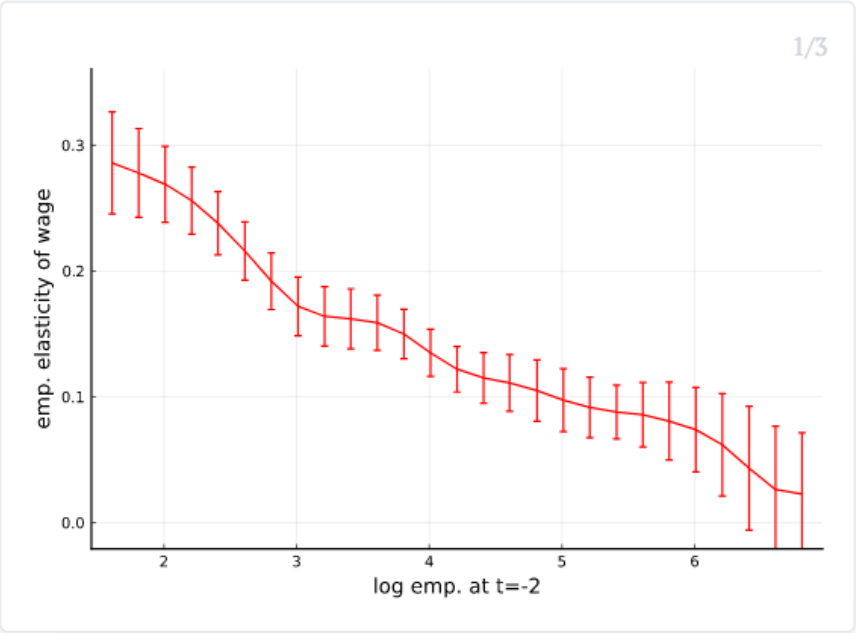
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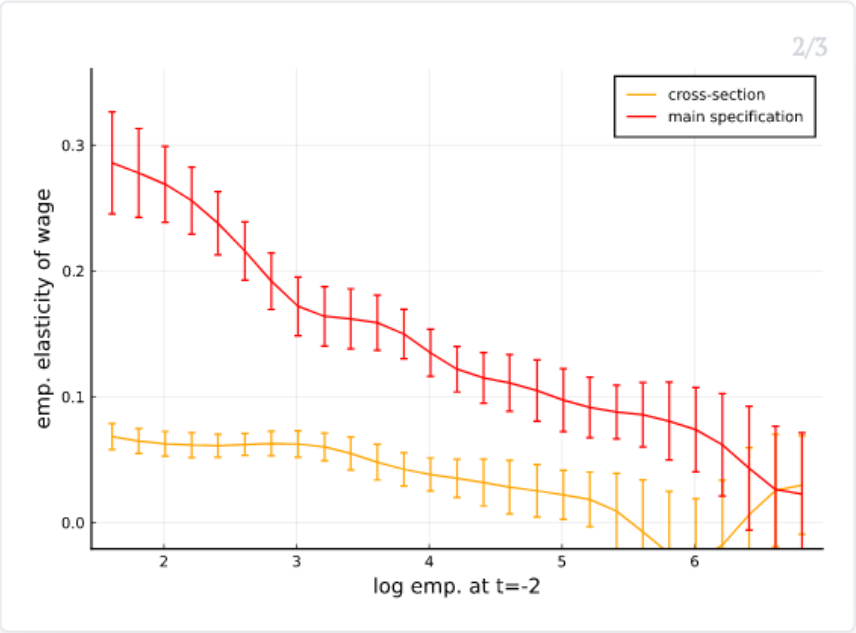
Size elasticity of wages - conditional on size



Main findings

1. Employment elasticity of wages decreases as firms get larger
2. Level is much larger than estimates from the cross-section

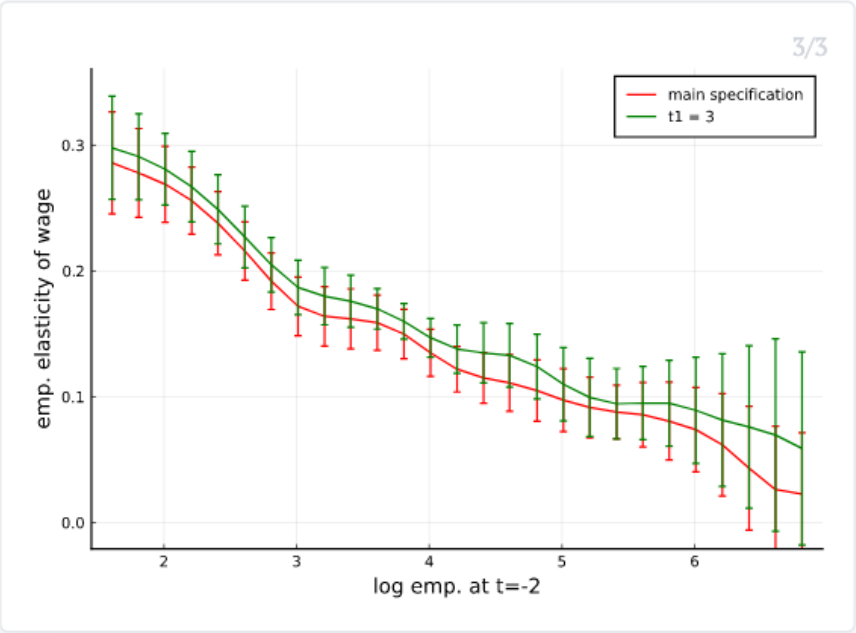
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Size elasticity of wages - conditional on size



Main findings

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Size elasticity of wages - robustness

1. Control for market size
   - we estimate elasticities by firm size and overall market size
2. Control for worker composition in L
   - we compute AKM worker effects (including firm-time FE) and construct effective firm labor size that takes into account worker heterogeneity
3. Run separately by education groups
   - estimate on college and non-college workers separately
4. Run for low and high labor-to-material ratio firms
5. Focus on small shocks
6. Use hourly wage rather than yearly earnings

External IV - unconditional

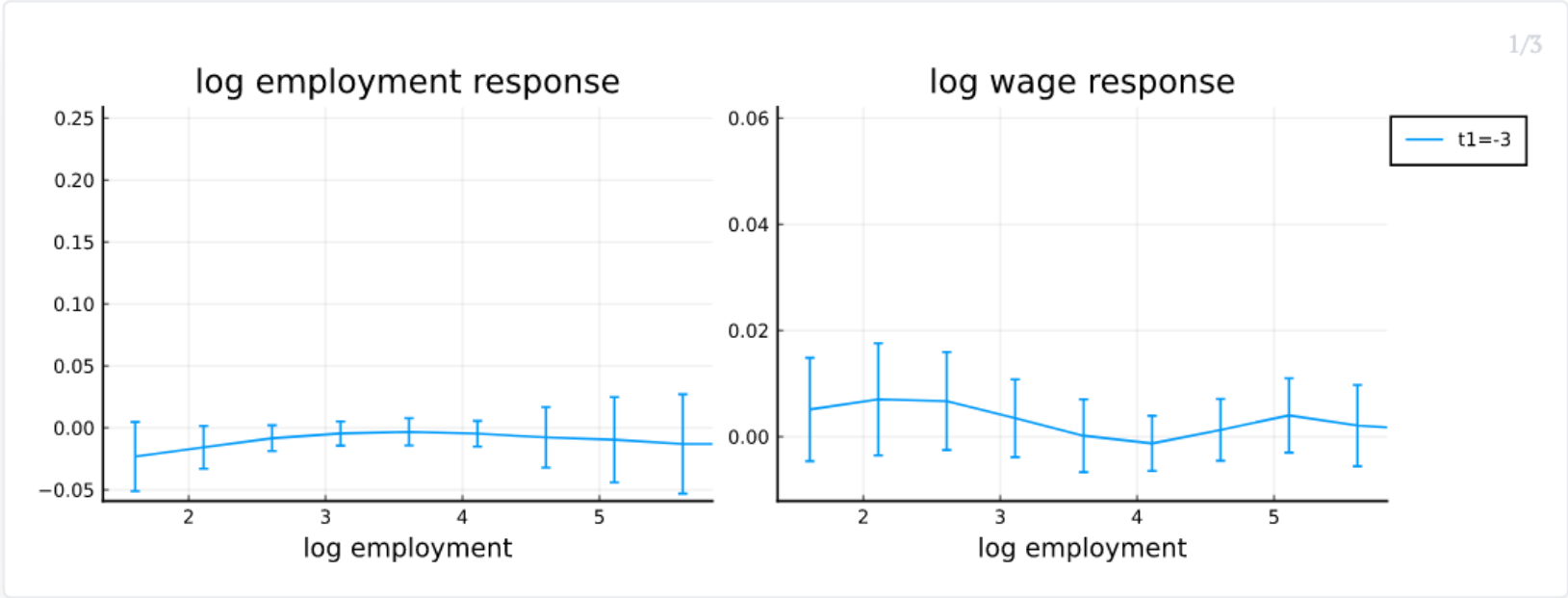
First stage and reduced form

- Within each cohort t_0
  - treatment group includes firms which win their first procurement auction in t_0
  - control group includes firms which win their first procurement auction later than $t_0 + 3$ or never
- Other elements of the analysis remain the same

	Internal			External		
	RF	FS	IV	RF	FS	IV
Placebo	0.000	-0.008		0.004	-0.012	
	(0.001)	(0.002)		(0.003)	(0.004)	
Event-time = 3	0.037	0.180	0.203	0.013	0.092	0.143
	(0.002)	(0.006)	(0.011)	(0.003)	(0.008)	(0.037)

External IV - conditional on size

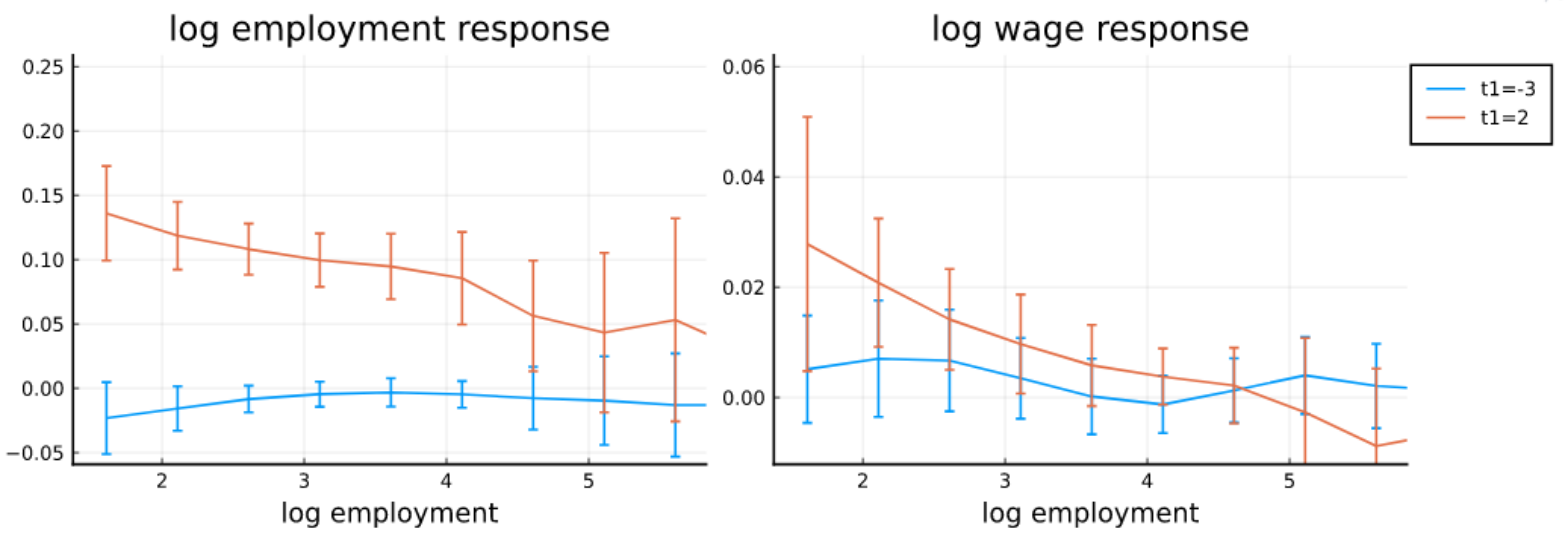
First stage and reduced form



- First stage is stronger among smaller firms

External IV - conditional on size

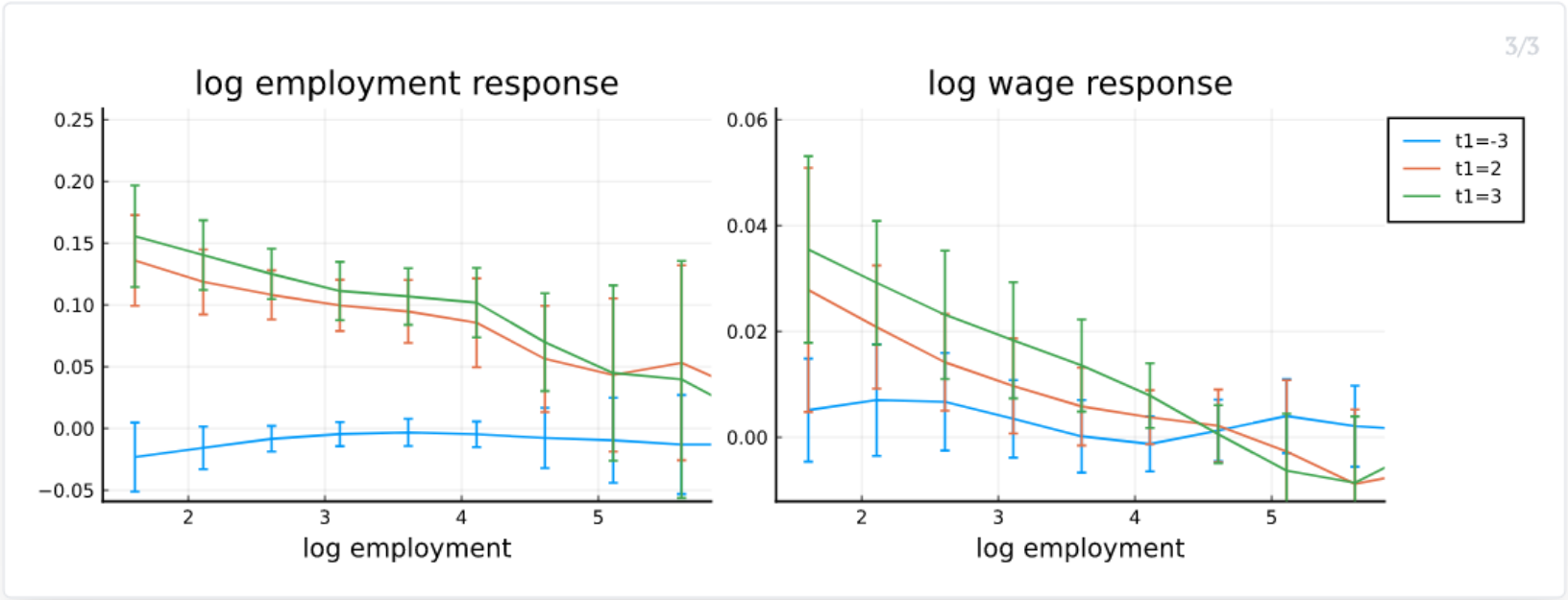
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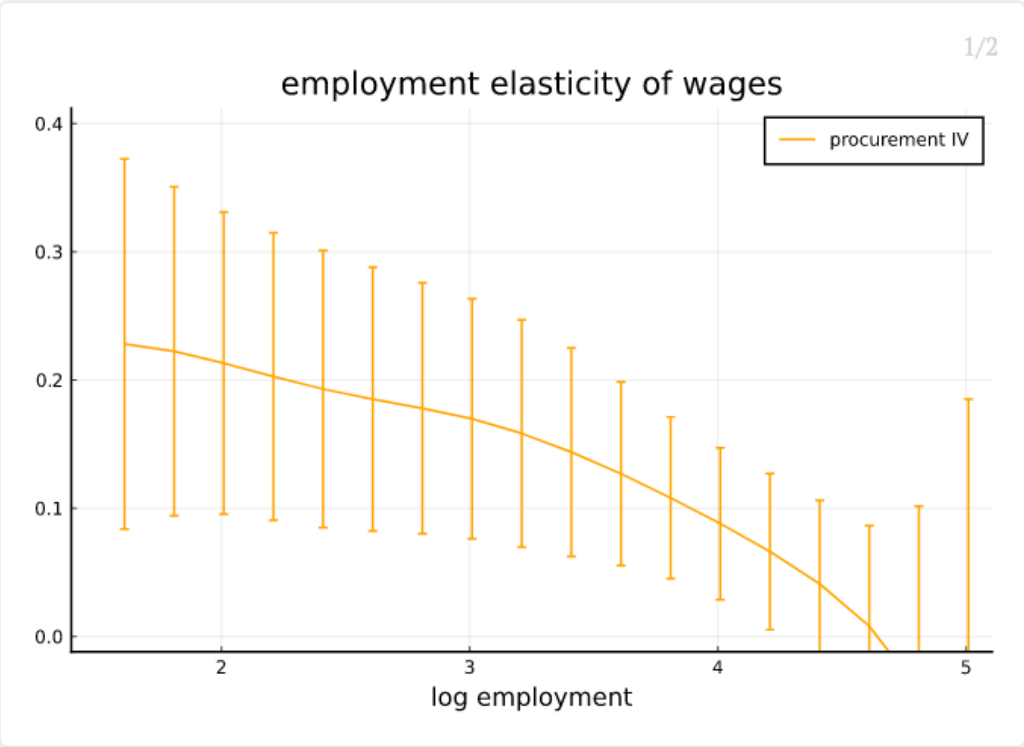
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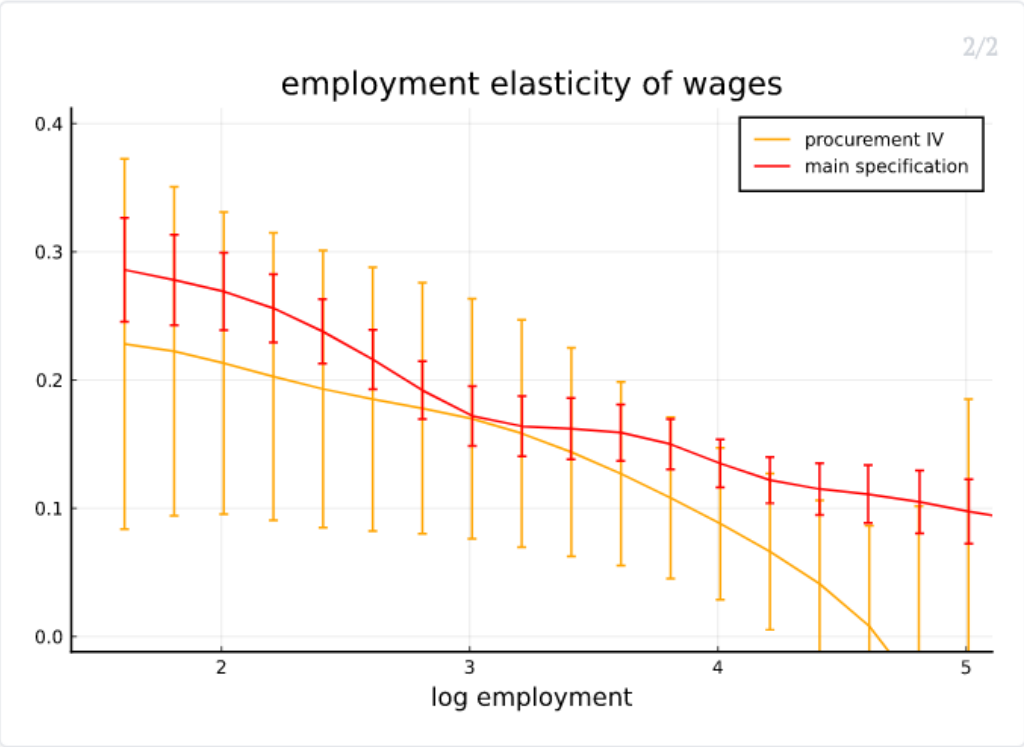
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External IV - elasticity



- Elasticities decrease with size, qualitatively similar

External IV - elasticity



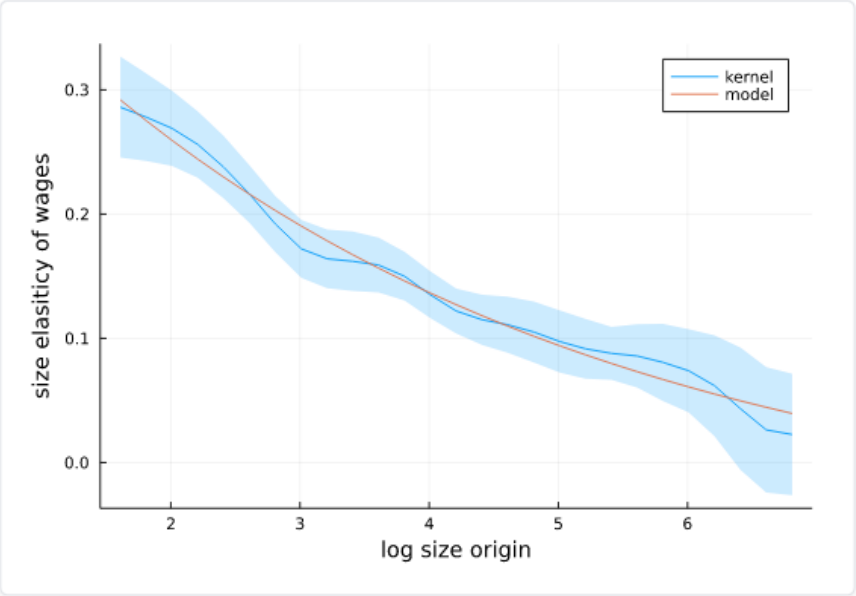
- Elasticities decrease with size, qualitatively similar

Fitting a functional form for $C(\cdot)$

- We fit the Kimball aggregator from Kleenow and Willis (2016)

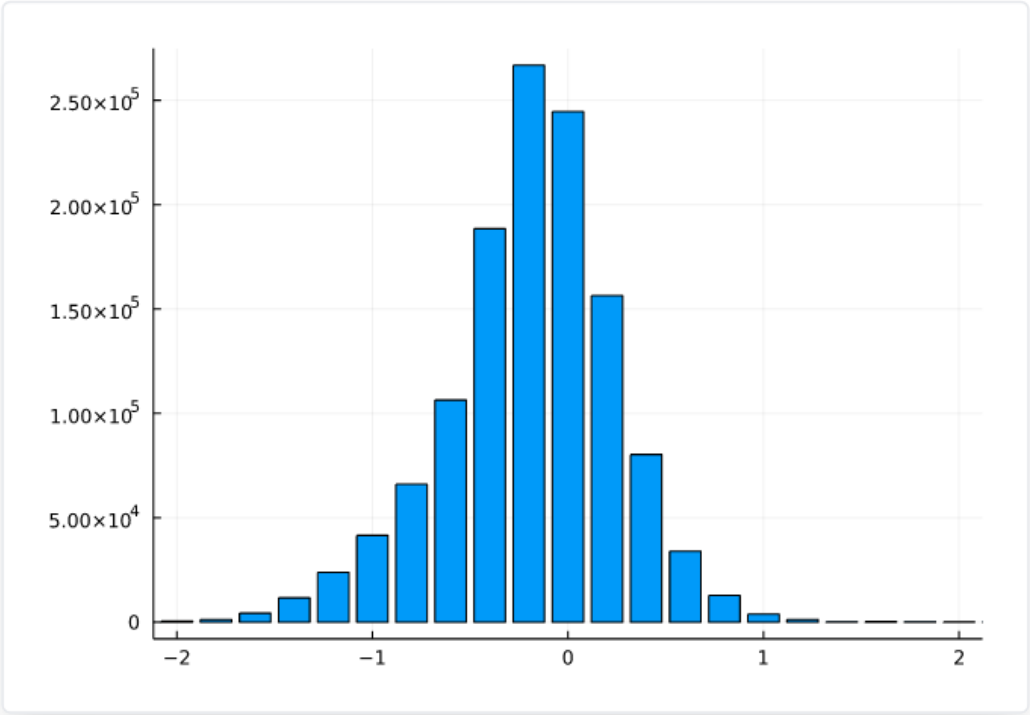
$$C(L) = L \exp\left(\frac{a}{b} L^b\right)$$

- Estimation gives $a = 0.51(0.056)$ and $b = -0.24(0.04)$



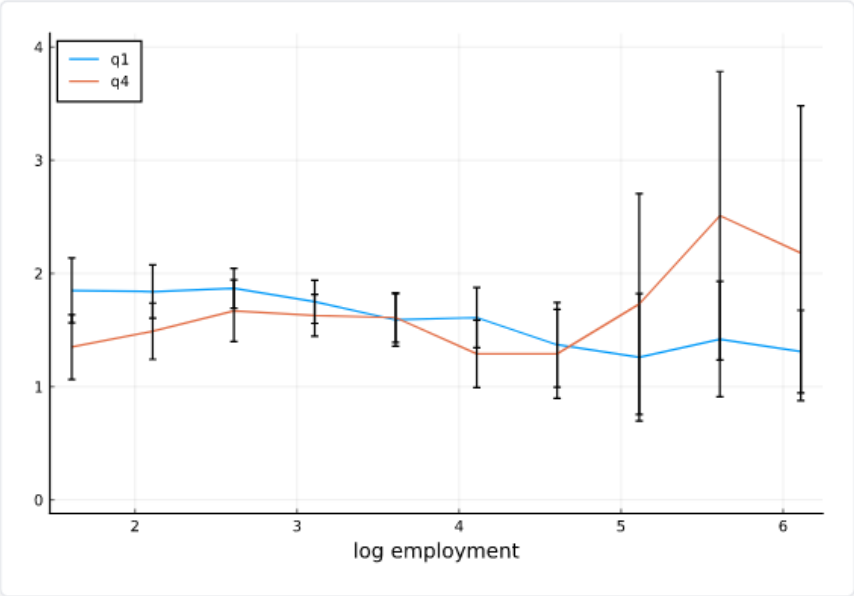
Extract the δ_j

- We estimate the δ_j using $C(L)$ and firm accounting wage bill



Employment elasticity of material

- We estimate $\varepsilon_{V,L}(V, L)$ for 4 quartiles of L/V ratios



- $\varepsilon_{V,L}(V, L) \geq 1$: firms substitute from L to V
- elasticity doesn't vary much with V, suggests iso-elastic $G(V)$

Fitting functional forms for $G(\cdot)$ and $H(\cdot)$

- We allow for different returns and a common scale effect

$$G(V) = V^{\beta_V}$$
$$H(L) = e^{\frac{\beta_L}{\gamma}L^{\gamma}}$$

- as $\gamma \to 0$ we get $(1-\omega_j)V^{\beta_V} + \omega_j L^{\beta_L}$ and nest the CES, and hence also Cobb-Douglas
- γ allows for the complementarity between L and V to vary with scale

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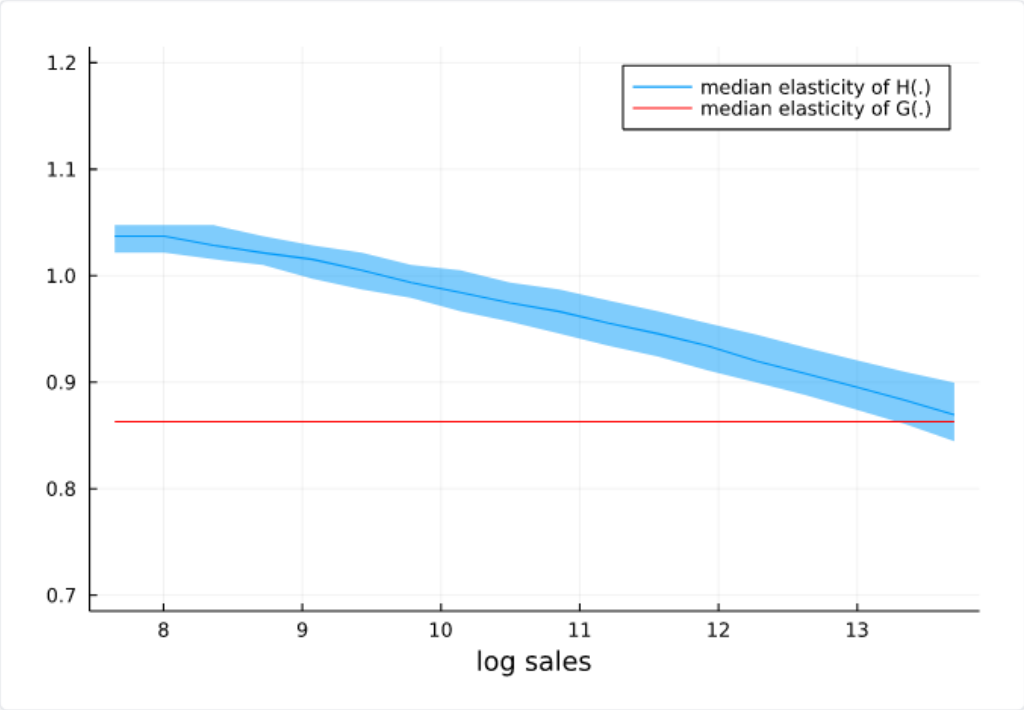
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- γ allows for the complementarity between L and V to vary with scale

Estimation

- $\beta_V = 0.86, \beta_L = 1.12$ and $\gamma = -0.04$

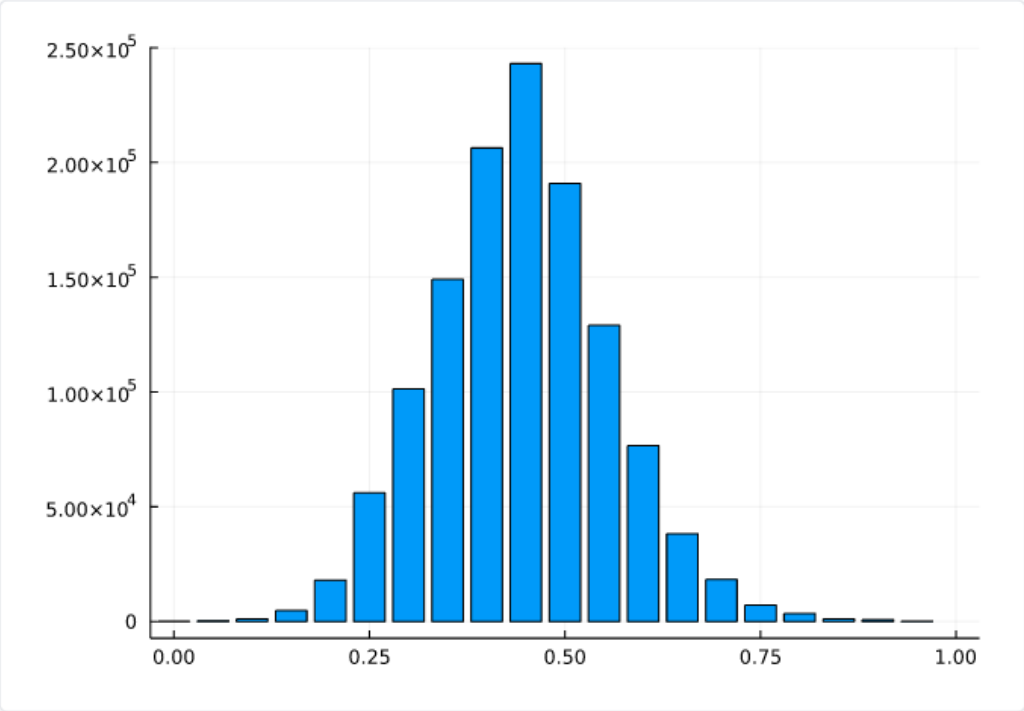
Fit

Comparing H and G across sales

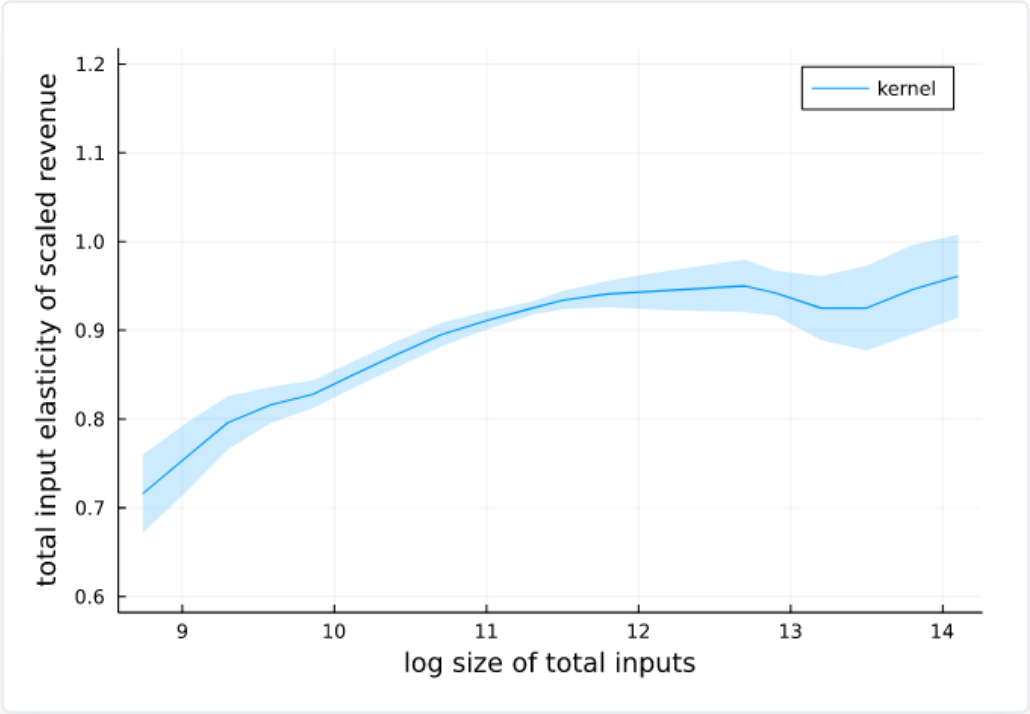


Extract the ω_j

- We estimate the ω_j using $G(V)$ and $H(L)$
- We scale to center mean at 0.5



Composite input elasticity of revenue

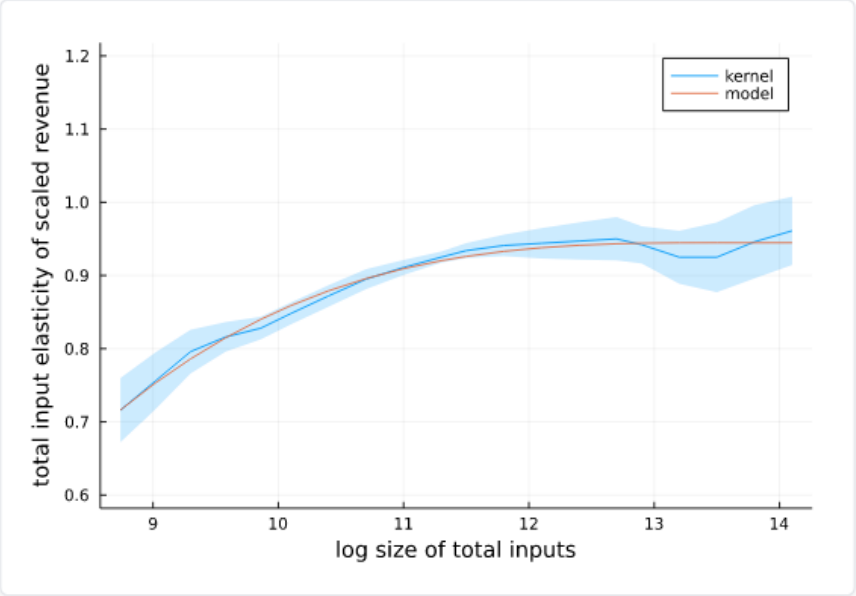


- Elasticity is increasing in composite input

Functional form for $F(\cdot)$

- We fit a linear elasticity function

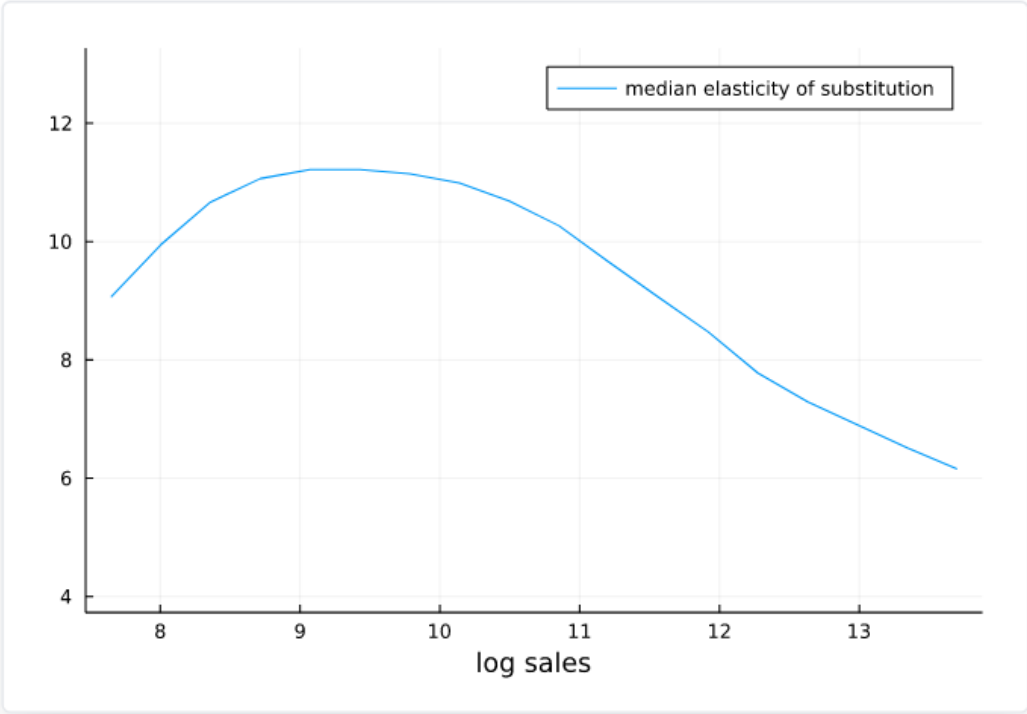
$$F(S) = S^{\sum_{p=0}^{3} \alpha_p + (\log S)^p}$$



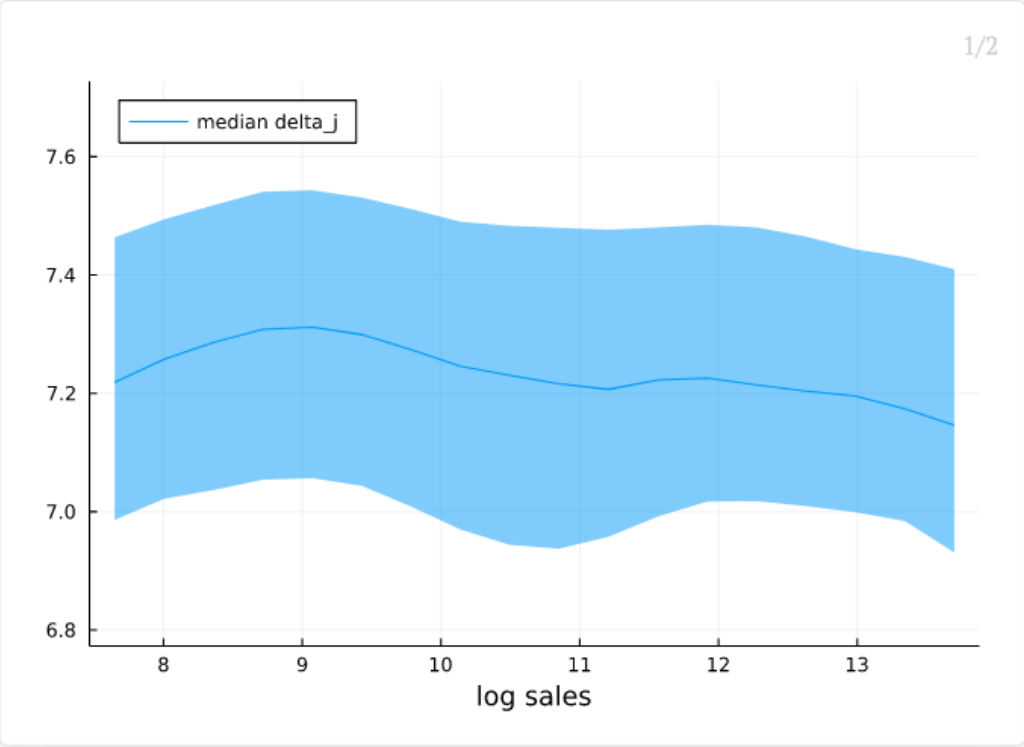
Recap of our structural estimation

- Labor cost
  - $\delta_j C(L) = \delta_j L \exp\left(\frac{a}{b} L^b\right)$
  - $a = 0.51(0.056)$ and $b = -0.24(0.04)$
- Composite input
  - $S_j = \omega_j e^{\frac{\beta_L}{\gamma} L^\gamma} + (1 - \omega_j) V^{\beta_V}$
  - $\beta_V = 0.86, \beta_L = 1.12$ and $\gamma = -0.04$
- Revenue function
  - $F(S) = S^{\sum_{p=0}^{3} \alpha_p + (\log S)^p}$
  - $\alpha = [-3.99, 1.09, -0.08, 0.002]$

Elasticity of substitution

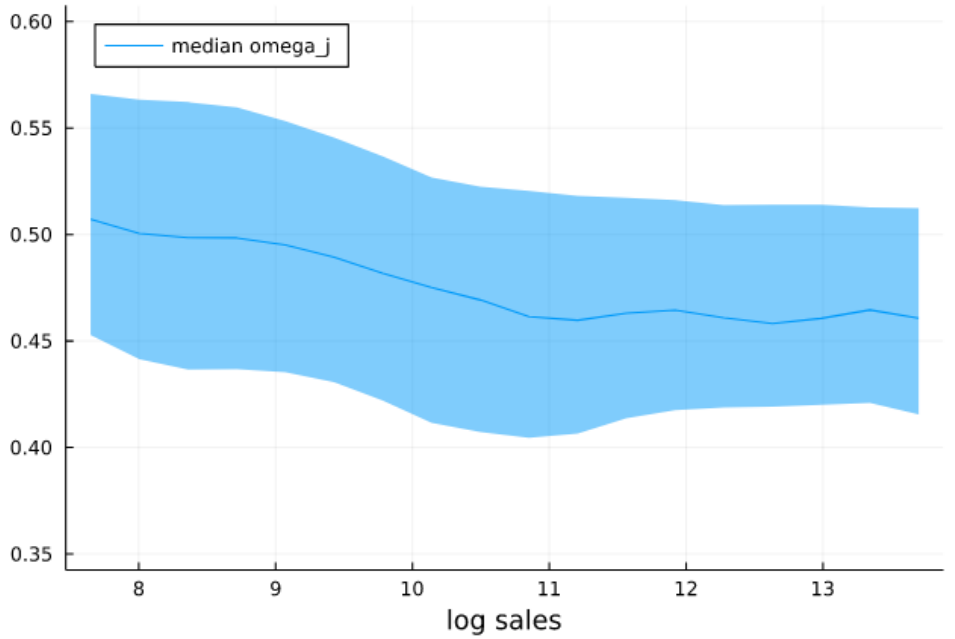


Firm heterogeneity in the cross-section



- Labor costs δ_j decrease with sales, at a slow rate
- Production input mix parameter ω_j decreases with sales

Firm heterogeneity in the cross-section



- Labor costs δ_j decrease with sales, at a slow rate
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Preliminary take-away

- Labor costs
  - costs are upward-sloping $\longrightarrow$ substitute away from L ✅
  - wage elasticities decrease $\longrightarrow$ markdowns don't increase with size ❌
- Production (preliminary)
  - relative returns to labor and material: appear to favor labor ❌
  - ω_j decreases and alrge elasticity of substitution suggests relatively less labor ✅
  - revenue elasticity increases with size: not sure yet ❓