Correcting Market Power with Taxation

A Sufficient Statistic Approach

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Motivation

- Concern that monopoly power is on the rise.
  - Higher firm concentration across industries
  - Higher markup dispersion
- Differential tax/subsidy of firms could alleviate misallocation.
- Should we tax large and powerful firms or small unproductive ones? How big are the gains?
- Most current approaches rely on parametric assumptions.

In this Paper

- Analytical formula for the welfare effect of general shocks that features
  - Markup $\mu_f = \frac{\text{price}}{\text{marginal cost}}$
  - Output Responsiveness $\Delta = \frac{\text{\% change in output}}{\text{\% shock in variable costs}}$
- Show that with a standard production function assumption one can recover Δ non-parametrically.
- Using the largest survey of UK firms, I find that at the industry level:
  - Markups decrease in firm size
  - The output responsiveness increases in firm size
- Evaluate the welfare gains from a simple revenue-neutral VAT reform where the tax rate is dependent on firm sales.

Related Literature

- **Increasing Markup & Falling Labour Share**
  De Loecker and Eeckhout (2019), Autor et al. (2017), Barkai (2016), Gutierrez and Philippon (2016), Kehrig and Vincent (2017), Gutierrez (2017), Hsieh and Rossi-Hansberg (2019), Neiman and Karabarbounis (2014), Decker et al. (2018)

- **Misallocation in General Equilibrium**
  Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Baqaee and Farhi (2020), Edmond et al. (2018), Pellegrino (2019), Itskhoki and Moll (2019)

- **Tax/Cost Passthrough Estimation**
  Amiti et al. (2019), Carbonnier (2007), Danninger and Carare (2008), Besley and Rosen (1998), De Loecker et al. (2016)

Partial Equilibrium

- The equilibrium output response of a firm of cost type c is:

$$\frac{\hat{x}(c)}{x(c)} = \overbrace{(\varepsilon_{mr} + \varepsilon_{mc})^{-1}}^{\text{Firm-Specific Responsiveness}} \underbrace{\left(\frac{\hat{\lambda}}{\lambda} - \frac{\hat{c}}{c}\right)}_{\text{Net Cost Shock}}$$

- Where the output responsiveness is $\Delta = (\varepsilon_{mr} + \varepsilon_{mc})^{-1}$.
- The vector of the shocks $\hat{c}$ determines the GE effct that works through $\frac{\hat{\lambda}}{\lambda}$.
- Derive the rest of the equilibrium response $\{\widehat{M}_e, \hat{c}_d, \hat{\lambda}\}$.

More details

Welfare Effect

% change in income that keeps utility unchanged at initial prices.

$$\lambda \widehat{U} = \overbrace{-M_e \lambda U \int_0^{c_d} cv(x) \frac{\hat{c}}{c} dG(c)}^{\text{direct effect}} + \overbrace{\hat{c}_d M_e g(c_d) s_d \left[\frac{u(x_d)}{u'(x_d) x_d} - \mathscr{M} \right]}^{\text{selection}} + \overbrace{M_e \int_0^{c_d} \left[1 - \frac{\mathscr{M}}{\mu_f} \right] s(c) \frac{\hat{x}}{x} dG(c)}^{\text{reallocation}}$$

- *Average Surplus:* $\mathscr{M} = \frac{\int_0^{c_d} u(x(c)) dG(c)}{\int_0^{c_d} u'(x(c)) x(c) dG(c)}$.
- At the firm-level we need $\{\mu_f, \Delta\}$

Extensions

- Multi-sector Economy link
  - Response of the firm distribution is independent across sectors
  - Aggregate using the observed sectoral sales shares
  - Reallocation across sectors does not matter to first-order
- Endogenous Labour Supply link
- Generalized Love-of-Variety link
- Materials in Production link

1 Framework

2 Identification

3 Empirical Findings

4 Tax Policy

Identification

- Exploiting the profit-maximizing condition $mr_{it} = mc_{it}$ details

$$\frac{\partial\, VC_{it}}{\partial\, S_{it}} = 1 - (\varepsilon_{it}^{vc}\Delta_{it})^{-1}$$

- Let the returns to scale in the variable input bundle be r so that $\varepsilon_{it}^{vc} = 1/r$.

- Recover Δ_{it} non-parametrically from the slope estimator.

Estimation

- Estimate the slope $\frac{\partial VC_{it}}{\partial S_{it}}$ by running a non-parametric kernel estimate by industry-year, and *controlling for capital stock*.
- Firm-level markups are recovered using the ratio estimator

$$\hat{\mu}_{it} = r \frac{\hat{S}_{it}}{VC_{it}}$$

- I assume slightly decreasing returns to in labour and materials by choosing $r = 0.95$.
- Data come from the ABS(ARD) which after cleaning includes about $20k$ observations per year.

1 Framework

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- Markup
- Output Responsiveness

4 Tax Policy

Firm Markups in the Cross-Section

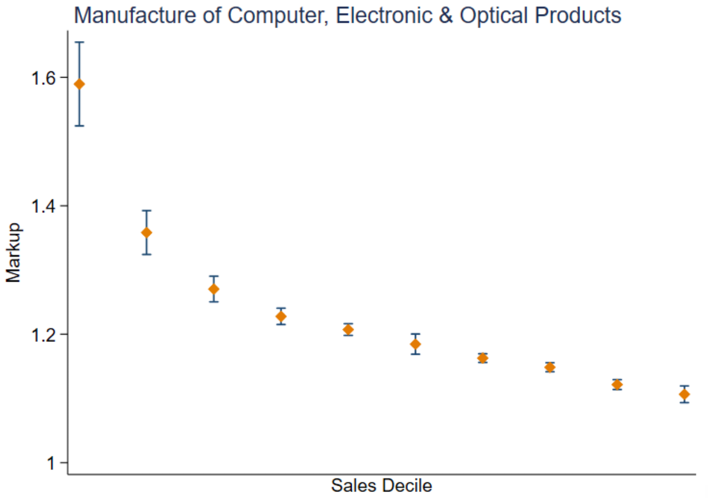
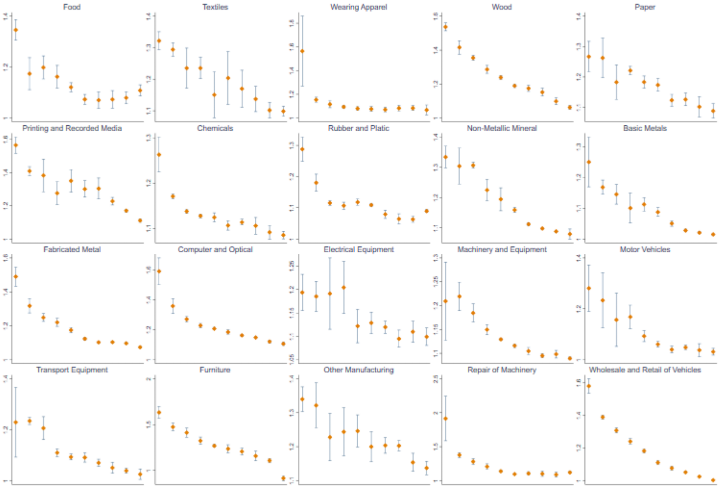


Figure: Dots indicate coefficient estimates of the median markup and lines indicate 95% confidence intervals obtained by bootstrapping. All observations are from 2010.

Markups fall with Firm Size

All Industries in Manufacturing



Output Responsiveness in the Cross-Section

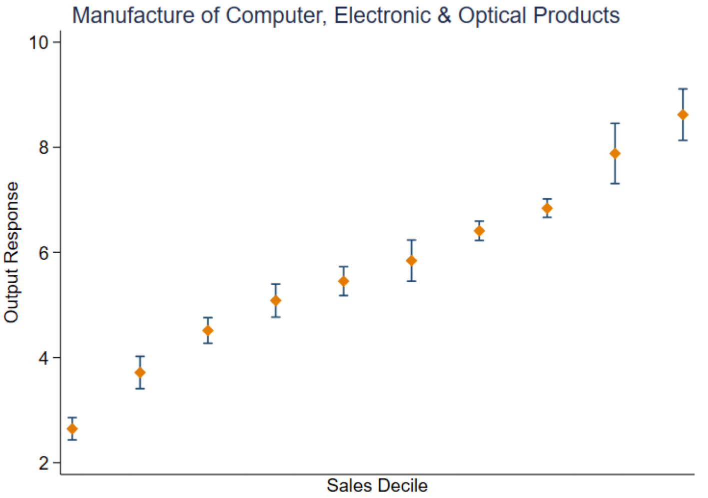
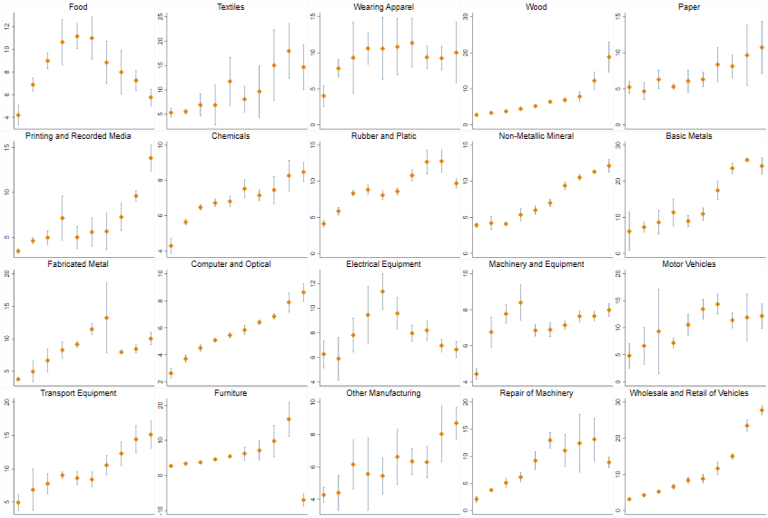


Figure: Dots indicate coefficient estimates of the median output responsiveness and lines indicate 95% confidence intervals obtained by bootstrapping. All observations are from 2010.

Output Responsiveness Increases with Firm Size

All Industries in Manufacturing



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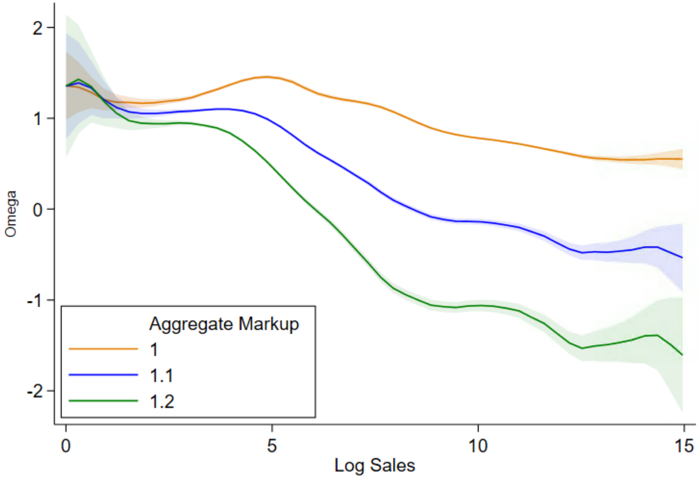
Tax Policy

- Consider increasing the sales tax rate for firms of type c^* only

$$\lambda \widehat{U} = \tilde{s}(c^*)[\overbrace{-(\omega(c^*) - \bar{\omega})}^{\text{reallocation}} + \overbrace{(\psi - \lambda U)\widehat{\mathscr{R}}(c^*)}^{\text{direct effect}}]$$

- Intuition: We want to tax firms that have welfare weights that are below the average $\bar{\omega}$ and subsidies high-ω firms.
- Kill off the direct term by making the tax change revenue-neutral.

Welfare Weights for all Firms

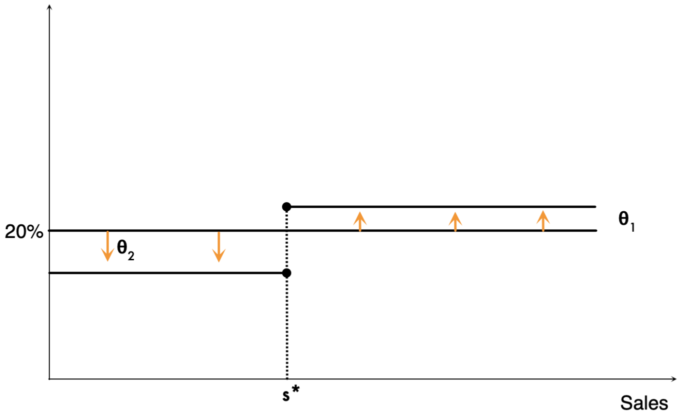


The shaded area denotes the 95% CI for the mean.

By Sector

A Bracket Tax Reform of VAT

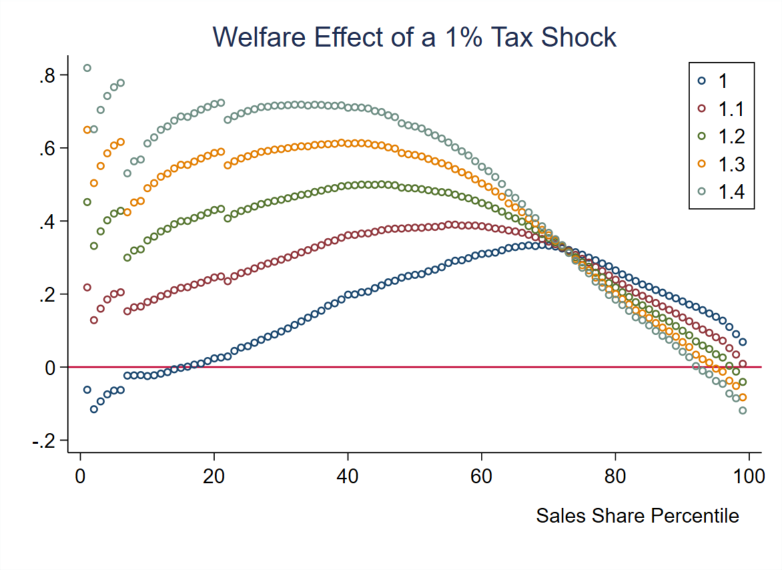
- Consider a *revenue neutral* tax reform with a single threshold c^* which corresponds to some s^*.



Application to the UK

- I start from the observed market equilibrium in 2010.
- I assume a fixed initial VAT Rate of 20% for all firms.
- I construct weights to match the sales distribution in the BSD.
- To make the numbers comparable across calibrations I use $\frac{\hat{U}}{U}$ instead of the money metric measurement $\lambda \hat{U}$.

Results for the UK



A VAT Reform in the UK

Let's translate the previous graph into policy

- Consider increasing the VAT rate of large firms from 20% to 24%. That implies that $\theta_1 = 0.05$.

- Assume that we pick the threshold at the 60th percentile and take $\lambda U = 1.2$ as the benchmark case.

$$\frac{\widehat{U}}{U} = 0.05 \times \textit{Welfare Multiplier} = 0.05 \times 0.4 = 0.02$$

- This corresponds to a sales threshold of £2m.

- This is pretty high compared to Edmond et al. total consumption equivalent gains of 6.6%!

Conclusion

- A welfare incidence formula in GE monopolistic competition models with firm heterogeneity.
- Use a novel identification strategy to recover output responsiveness at the firm level.
- Document substantial firm and industry-level heterogeneity:
  - Markups are decreasing in firm size and especially so for the smallest firms.
  - Output responsiveness increase in firm size
- Increasing VAT for firms with sales above £2m from 20% to 24% and giving a cut to smaller firms leads to a 2% utility gain. The gains are robust and positive for different sales thresholds.

Materials as Inputs in Production

- Varieties are produced using both materials and labour.
- Materials are produced with labour only and a linear production.
- They can be priced at a markup with $p^m \geq 1$ given exogenously.
- The problem of the firm now becomes a two-stage one:
  1. Minimize costs given any desired output level x

     $$VC(p^m, \zeta, x) \equiv \min_{l,m} l + p^m m \quad \text{s.t} \quad \zeta F(l,m) \geq (x)$$

  2. Maximize profits by choosing the optimal x^*
- Cost-minimization requires that $\frac{F_l'(l^*,m^*)}{F_m'(l^*,m^*)} = \frac{1}{p^m}$.
- Homogeneity of the production function implies that the ratio of inputs used depends only on the relative prices (p^m). main

Materials as Inputs in Production

- Assume homogeneity of degree r: $F(\theta l, \theta m) = \theta^r F(l, m)$.
- The optimal ratio of inputs depends only on the ratio of prices $\frac{l^*}{m^*} = \eta^*(p^m)$.
- Re-write the cost function as following

$$
\begin{aligned}
VC(p^m, \zeta, x) &= (p^m + \eta^*)\,[F(\eta^*, 1)]^{-1/r} \cdot \zeta^{-1/r} \cdot x^{1/r} \\
&= \psi(p^m) \cdot c \cdot v(x)
\end{aligned}
$$

- **Equilibrium Conditions**

$$\lambda[u''(x(c))x(c) + u'(x(c))] = \psi(p^m)cv'(x)$$

$$\lambda[u'(x(c_d))x(c_d)] = \psi(p^m)c_d v(x(c_d)) + f$$

$$\lambda \int_0^{c_d} u'(x(c))x(c)dG(c) = \int_0^{c_d} [\psi(p^m)cv(x(c)) + f]dG(c) + f_e$$

$$M_e\left(\int_0^{c_d}\left[\frac{1+\eta^*}{p^m+\eta^*}\psi(p^m)cv(x(c)) + f\right]dG(c) + f_e\right) = 1$$

Derivation

- Given the assumption of the model we have that:

$$S_{it} = \lambda_t u'(x^*(\lambda_t, c_{it}))x^*(\lambda_t, c_{it})$$
$$VC_{it} = c_{it} v(x^*(\lambda_t, c_{it}))$$

- Taking the derivative of sales wrt the cost-shifter

$$\frac{\partial S_{it}}{\partial c_{it}} = \lambda_t[u''(x^*_{i,t})x^*_{it} + u'(x^*_{it})] \times \frac{\partial x^*_{it}}{\partial c_{it}} = mr_{it} \times \frac{\partial x^*_{it}}{\partial c_{it}}$$

- Taking the derivative of variable costs wrt the cost-shifter

$$\frac{\partial VC_{it}}{\partial c_{it}} = v(x^*_{it}) + c_{it} v'(x^*_{it}) \times \frac{\partial x^*_{it}}{\partial c_{it}} = v(x^*_{it}) + mc_{it} \times \frac{\partial x^*_{it}}{\partial c_{it}}$$
$$= mc_{it} \times \left(\frac{v(x^*_{it})}{c_{it} v'(x^*_{it})} + \frac{\partial x^*_{it}}{\partial c_{it}} \right)$$
$$= mc_{it} \times \left(\frac{x^*_{it}}{c_{it}} \frac{1}{\varepsilon_{vc,it}} + \frac{\partial x^*_{it}}{\partial c_{it}} \right)$$

main

Generalized Monopolistic Competition

- There is a representative household that buys a continuum of varieties i.
- Agents supply labour inelastically. Wage is normalized to 1.
- Utility maximization problem of the household

$$\max_{[x_i]_{i\in I}} \int u(x_i)\, di \quad \textit{subject to} \quad \int p_i x_i \, di \leq 1$$

- Inverse demand is $p_i = \lambda \, u'(x_i)$ where $\lambda = \left(\int u'(x_i) x_i di\right)^{-1}$

main

Firms

- The firm type is given by c and it determines the total production costs $cv(x) + f$.
- Profit maximization

$$\max_{x} \quad \underbrace{\lambda u'(x)}_{p(x)} x - cv(x) - f$$

- There is an entry cost f_e that a firm needs to pay before it learns its type c drawn from an exogenous distribution $G(c)$.
- Firms that are too unproductive $c > c_d$ will shut down.
- Equilibrium is given by $\{x(c), c_d, \lambda, M_e\}$.

Deriving the Cost Function

- The problem of a firm with productivity ω and capital K is

$$\min \quad p^M M + L \quad \text{st} \quad \omega F(M, L, K) \geq x$$

- Optimality requires that

$$\frac{p^M}{p^L} = \frac{F_M(M^*, L^*, K)}{F_L(M^*, L^*, K)} = \frac{M^{*\,r-1} F_M(1, \frac{L^*}{M^*}, K)}{M^{*\,r-1} F_L(1, \frac{L^*}{M^*}, K)} \tag{1}$$

- Therefore the optimal ratio of variable inputs is $\frac{L^*}{M^*} = \eta^*(p^M, K)$
- Optimality also requires that the production constraint binds

$$x = \omega F(M^*, L^*, K) = \omega M^{*\,r} F\left(1, \frac{L^*}{M^*}, K\right) \tag{2}$$

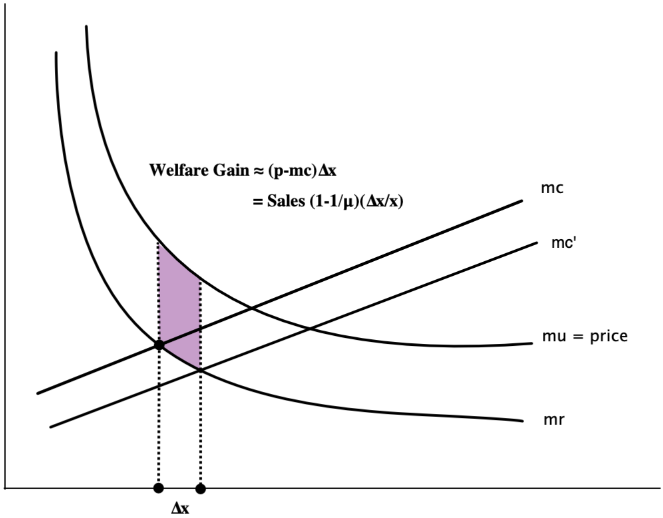
- Which allows us to solve for material inputs as

$$M^* = F(1, \eta^*(p^M, K), K)^{-1/r} \cdot \omega^{-1/r} \cdot x^{1/r}$$

- $p^M M^* + L^* = (p^M + \eta^*(p^M, K)) M^* = \mathscr{H}(p^M, K_{it}) \cdot \omega^{-1/r} \cdot x^{1/r}$

main

Welfare Effect



main

Endogenous Labour Supply

- Disutility from working $U = M_e \int_0^{c_d} u(x(c))\, dG(c) - \varphi(l)$
- This shows up in the equilibrium conditions in:
  1. Resource Constraint $M_e \left(\int_0^{c_d} [cv(x(c)) + f] dG(c) + f_e \right) = l$
  2. Labour-Consumption Choice
- Extra term in the welfare formula

$$\lambda \hat{U} = \lambda \hat{U}^{\text{old}} + (\lambda U - 1) \frac{\hat{l}}{l}$$

- Can be easily incorporated using the fact that

$$-\eta_l \frac{\hat{l}}{l} = \frac{\hat{\lambda}}{\lambda} \quad \text{where} \quad \eta_l = \frac{l\varphi''(l)}{\varphi'(l)}$$

main

Generalizing Love-of-Variety

- $U = H(M_e) \int_0^{c_d} u(x(c))\, dG(c)$ where before $H(M_e) = M_e$
- Inverse Demand is unaffected by the function $H(\cdot)$

$$p(x) = \frac{u'(x)}{M_e \int_0^{c_d} u'(x(c))x(c)\, dG(c)}$$

- As a result, the market equilibrium will therefore be unchanged!
- It will matter for the welfare incidence as

$$\lambda \hat{U} = (\eta_e \lambda U) \frac{\hat{M}_e}{M_e} + M_e \lambda \hat{u}$$

where $\eta_e = \frac{M_e H'(M_e)}{H(M_e)}$

main

Multi-Sector Economy

- k sectors with a continuum of varieties in each.
- Let $U^j = M_e^j \int_0^{c_d^j} u^j(x^j(c))\, dG^j(c)$ be the utility from sector j.
- Supply-side structure $\{v^j(\cdot), f^j, f_e^j, G^j(\cdot)\}$ can be sector-specific.
- Household's problem is now given by

$$\max_{[x_i^j]_{i\in I}} \quad \mathscr{F}(U^1, U^1, \dots U^k) \qquad st \qquad \sum_{j=1}^{k} M_e^j \int p^j(c) x^j(c)\, dG^j(c) \leq 1$$

- Let $\{s^j, u^j\}$ be the average firm sale and firm utility in sector j.

main

Multi-Sector Economy II

- Re-write household's problem as a two-stage maximization:
  1. Allocate expenditure shares across sectors $\{\alpha^1, \alpha^2, \ldots, \alpha^k\}$
  2. Choose the optimal bundle of varieties $[x^j(c)]$ given prices and α^j.

- First-stage optimality requires that

$$\mathscr{F}_j' \frac{u^j}{s^j} - \frac{1}{\psi} = 0$$

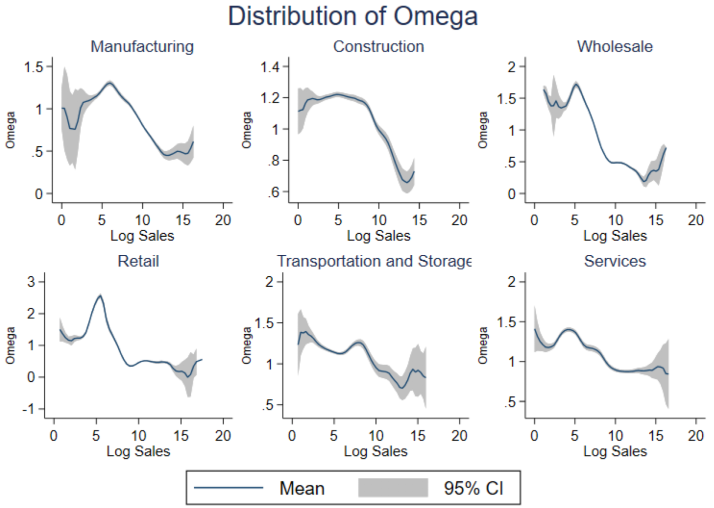
- Second-stage optimality coupled with monopolistic competition determines $\{c_d^j, x^j(c), \lambda^j\}$ and therefore $\{s^j, u^j\}$.

- One can show that the welfare effect is

$$\psi \hat{U} = \sum_{j=1}^{k} \alpha^j \left[\frac{\hat{\alpha}^j}{\alpha^j} + \frac{\hat{u}^j}{u^j} - \frac{\hat{s}^j}{s^j} \right]$$

main

Welfare Weights by Sector



main

Estimation Assumptions

- **A1** The production function is common to all firms up to a Hicks-Neutral productivity term $x_{it} = \zeta_{it} F(M_{it}, L_{it}, K_{it})$.
- **A2** Firms face a common downward-slopping inverse demand curve $\lambda_t P(\cdot)$, but the final price is subject to an iid shock ψ_{it}.

$$P_{it}(x_{it}) = e^{\psi_{it}} \lambda_t P(x_{it})$$

- **A3** Capital is the only fixed input that is chosen at or before $t-1$ while labour and materials are both chosen flexibly at t.
- **A4** Demand for flexible inputs can be written as $M_{it} = \mathbb{M}(K_{it}, \omega_{it}), L_{it} = \mathbb{L}(K_{it}, \omega_{it})$ where both $\{\mathbb{M}, \mathbb{L}\}$ are strictly monotone in ω_{it} for any level of capital K_{it}.
- **A5** The production function is homogenous of degree r in materials and labour conditional on capital.

main

Estimating the Klenow-Willis Demand

- Using the inverse demand function we can write an expression of log sales to log elasticity.

$$ln\, S_{it} = a_t - \frac{1}{\kappa}\left(\frac{1}{\varepsilon_{it}} + ln\, \varepsilon_{it}\right)$$

- I run a non-linear least square estimation for to recover the superelasticity parameter κ.

- For comparison with Edmond et al. (2019), I use both my measure of variable costs (labour+materials) and labour only to construct firm level markups.

- Drop observations where markups are less than 1 which implies a negative elasticity.

- Run this by year-sector to control for the demand index.

main

Kimball Superelasticity in the Data

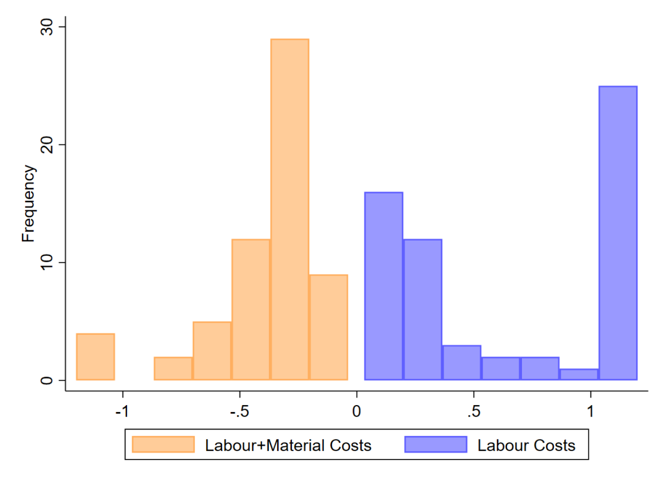


Figure: `kimball_superelast.png` Each estimate of the superelaticity parameter corresponds to a SIC2 industry in 2010. Values that are less than -1 or larger than one have been bunched together and are shown in the two tail columns.

Comparing R-squared by Variable Cost Measure

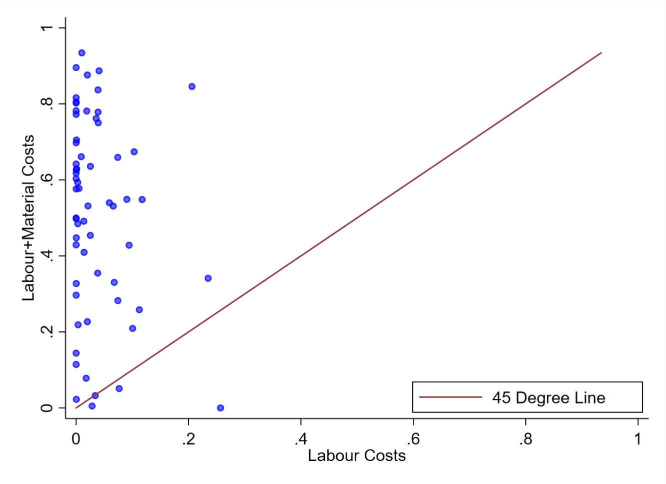


Figure: `kimball_fit.png`: Each point corresponds to a SIC2 industry in 2010.

main