How to Detect and Measure Labor Market Collusion?

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June 30, 2023
2023 International Conference on Competition and Regulation (CRESSE)

Motivation

- Renewed political interest in making labor markets more competitive.
  - DOJ/FTC investigation of merger effects on labor markets.
  - FTC proposal to ban Noncompete Clauses.
  - Investigation of labor market cartels across jurisdictions.
- Need for new (econometric) tools to study competition in labor markets.
- Focuses on most common type of collusion "No Poaching Agreements".
  - How to identify labor market cartels in practice? (detection)
  - How to measure their effects? (quantification)

Contribution

This paper proposes:

- Reduced-form wage loss estimation method,
- Structural model of labor market competition used for cartel detection.

Illustration: Collusion in Major League Baseball (1986-88).

Main Results:

- Players loss on average $\approx 27\%$ annual income, but highly heterogeneous.
- Developed and estimate a structural model of labor market competition.
- Model reveals collusive patterns:
  1. Decreasing mobility of workers across firms.
  2. Decreasing labor share of income.
  3. Increasing profits from retained employees.

Literature Review

- Models of Labor Market Competition: Card et al. [2018], Anderson and de Palma [1989], Azar et al. [2019], Roussille and Scuderi [2021], d'Haultfoeuille [2010], Lamadon et al. [2019], Dupuy and Galichon [2017], Lamy et al. [2022].
  → **Contribution**: based on Discrete Choice Theory adapted for labor data.

- Measuring Cartel Damages: Laitenberger and Smuda [2015] , Boyer and Kotchoni [2015], Gibson [2019], Leamer [2012].
  → **Contribution**: propose a new approach for relevant industry.

- Baseball, Competition, and Antitrust: Berri and Krautmann [2019], Ferguson et al. [2000], Scully [1974], Zimbalist [1992], Pape [2020].
  → **Contribution**: measure of productivity, labor share, and cartel effects.

Collusion in Major League Baseball (MLB)

Why study Major League Baseball?

- Excellent data: typically difficult to access.
  - Linked employer-employee data (1960-2000).
  - Many measures of productivity [Kahn, 2000].
  - Freely available from Baseball-Reference.com
- Relevant industry: labor is a strategic input in MLB.
  - Lithuanian Basketball League (2021).
  - Portuguese Football League (2022).
  - Polish Basketball League (2022).
- Well-defined: beginning and end dates following successful litigation.

This paper's approach: not particular to Baseball but works well nonetheless.

Collusion in Major League Baseball

Peter Ueberroth, MLB's Commissioner (CEO), at team owners' meeting.

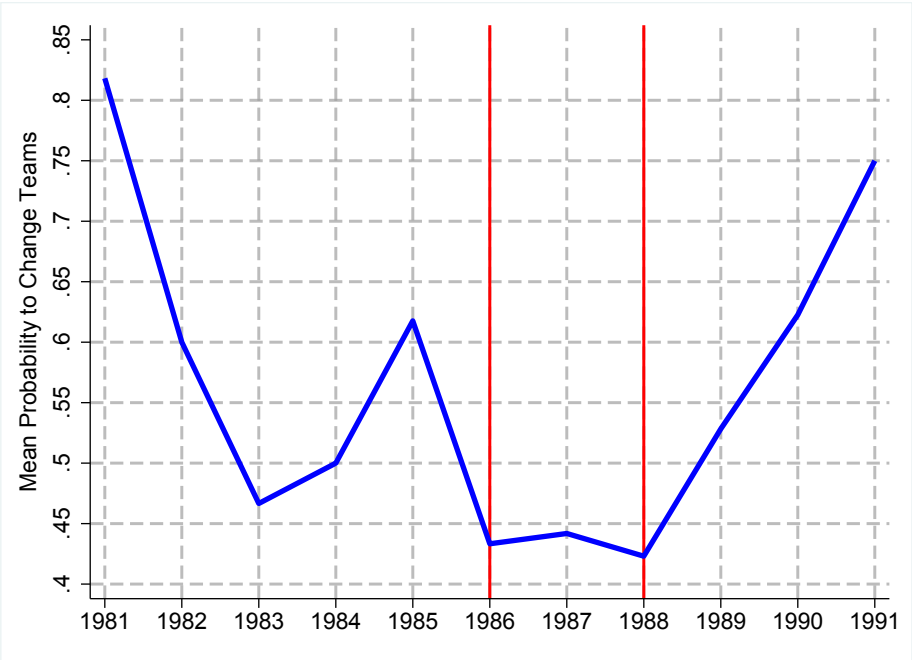
- Claimed that bidding wars were a "matcho thing".
- Polled the owners "eyeball-to-eyeball":

  I'm going to go around the room, and you have to tell me if you're going to be signing free agents. You're free to sign a free agent if you want, because we can't agree not to sign free agents. This is in no way binding and you have the right to change your minds. But I want to know those who are and those who aren't.

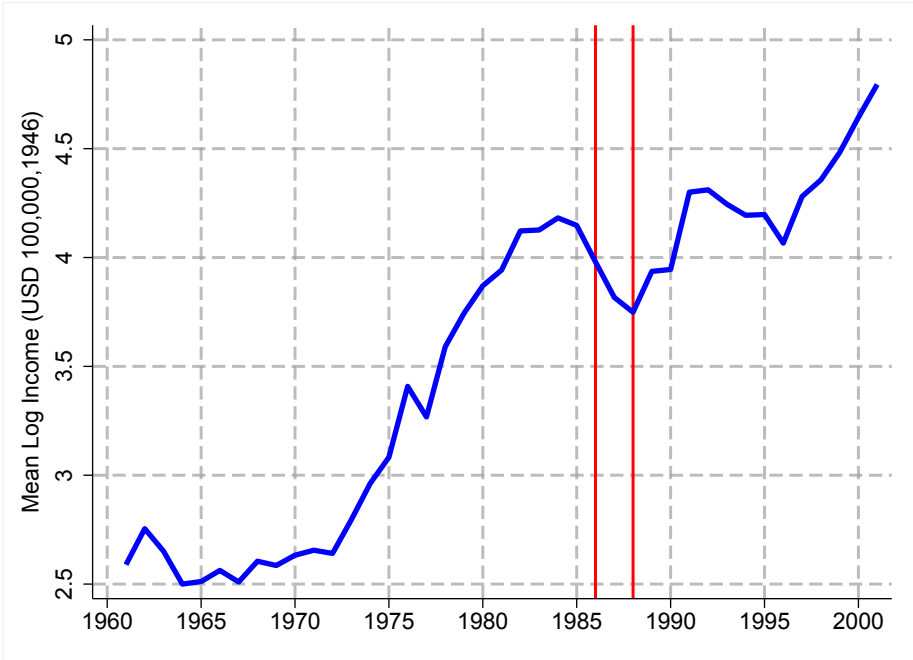
- Result: public salary and contract length discussion, no out-bidding.

■ This paper will not focus solely on free-agents.

Effects on Wages and Mobility



(a) Prob. Free-Agent Changes Team



(b) Real Mean Log Wages ($)

Observations:

- No Poaching Agreement is not fully enforced.
- Industry shocks make wage loss less clear.
- Time necessary before recovery of wages and mobility.

Damage Estimation

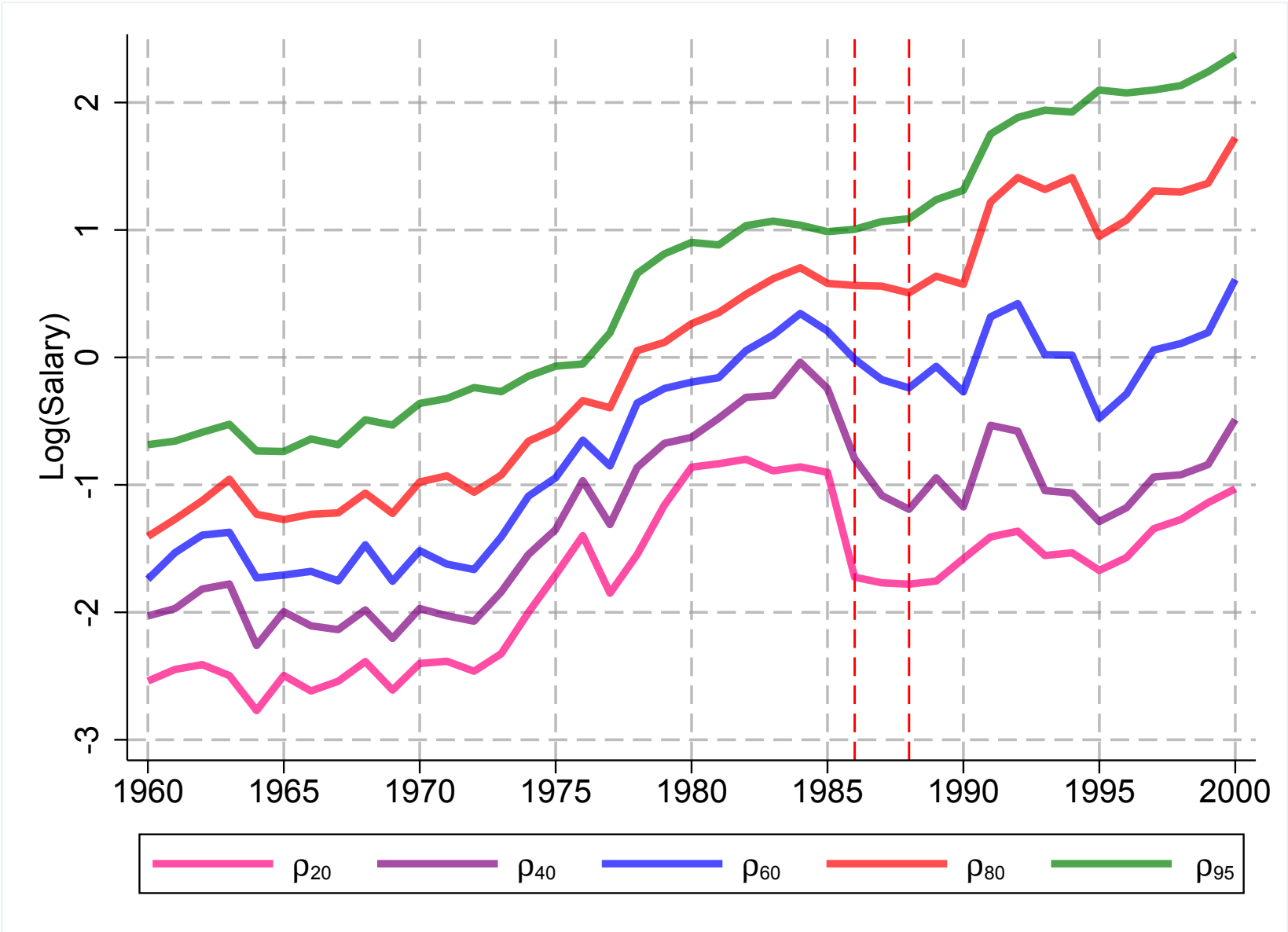
Goal: Measure income loss resulting from collusion.

- Necessary in class lawsuit [Leamer, 2012].
- Must be simple to explain to non-economist.
- Ideally should provide heterogeneous effects with testable robustness.
- Computationally tractable and require no special data.

Proposal: Inter-percentile Differences-in-Differences.

- Does all this !
- Method can be used outside of this context.

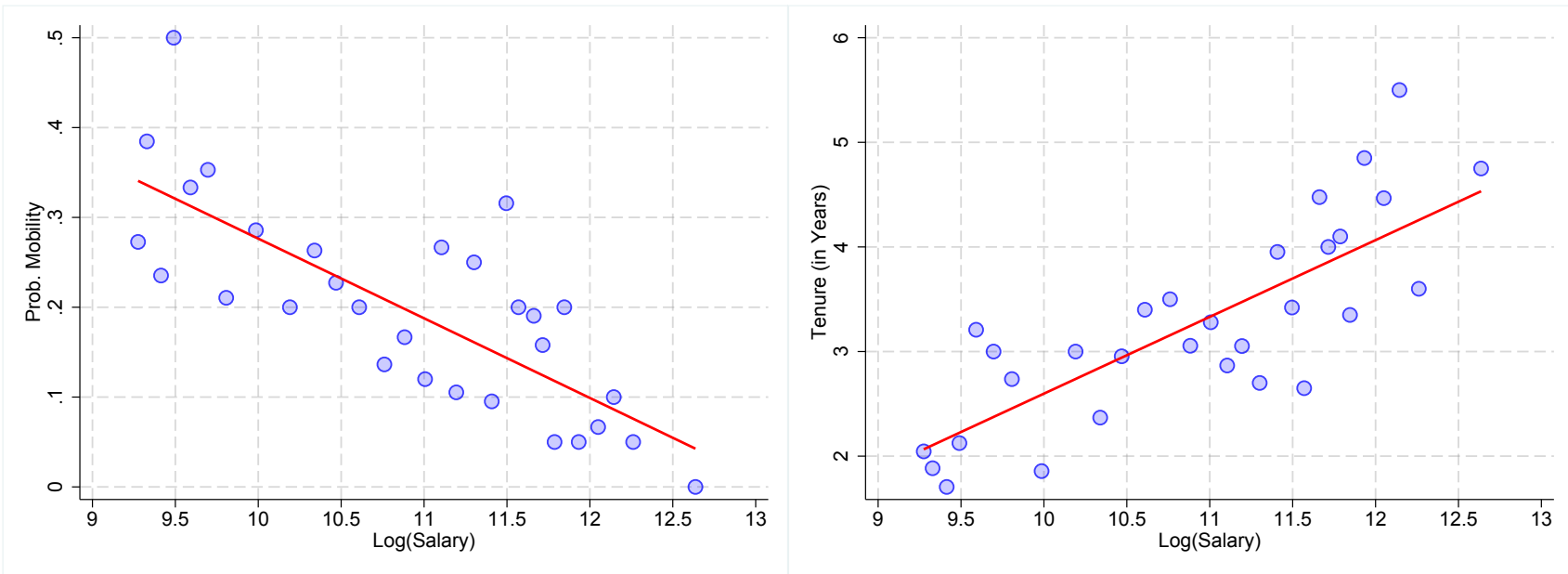
Inter-Percentile Differences-in-Differences



Why use the top 5% of earners?

At least three main reasons:

1. Statistics: Parallel trends seems reasonable (lower bound?).
2. Mobility: Players with *ex ante* limited mobility (not losing much).
3. Tenure: Players with greater tenure (can resist renegotiations).



(a) Income & Mobility (1985)

(b) Income & Tenure (1985)

Unconditional Quantile Regression

- UQR [Firpo et al., 2009]:
  - Measures how observation X_i changes statistic $iqr(X_1, ..., X_N)$.
  - Approximated by the Recentered Influence Function (RIF).
  - Can calculate a sample counter-part used in a regression model.

- Model: use in Diff-in-Diff framework for all percentiles $\rho \in \{1, 2, ..., 95\}$:

$$\text{RIF}\Big[\log(w)_{i,t}, iqr_{\log(w)}(\rho, 95)\Big] = \mu_\rho + \mathbb{1}(\text{Cartel}_t = 1)\tau_\rho + \mathbb{1}(\text{Post-Cartel}_t = 1)\gamma_\rho + \zeta^\rho_{i,t}$$

- Estimation: run OLS for each selected percentile (cluster bootstrap).

Summary Estimates

- Assume top 5% of earners are unaffected & parallel trends (control group).
- Estimate for each percentile:

	Mean	S.E.	25th perc.	Median	75th perc.	Min.
% Income Loss	-0.27	0.24	-0.51	-0.27	-0.01	-0.61

- In a before-after analysis, estimate of -34% ($\approx$ 2x those awarded).
- Advantages:
  - No additional data compared to before-after, runs with OLS.
  - Heterogeneous effects robust to industry shocks (DiD).
  - Observable selection (covariates) and event-study.

Structural Model of Labor Market Competition

Why a structural model?

- Cartel limits firms' ability to hire workers from other firms.
  $\rightarrow$ as if firms devalue the productivity of other workers.
- **Goal: model and measure devaluation.**
- Material evidence in antitrust case.

Labor Supply

Worker i with wage $w_t^{i\to j}$ from firm j at time t obtains mean utility

$$U_t^{i\to j} = X_t^{i\to j\prime}\beta + \alpha w_t^{i\to j} + \xi_t^{i\to j} \tag{1}$$

If unemployed, the mean utility is $U_t^{i\to U}$. The total utility is

$$V_t^{i\to j} = \begin{cases} U_t^{i\to j} + \epsilon_t^{i\to j} & \text{if employed,} \\ U_t^{i\to U} + \epsilon_t^{i\to U} & \text{if unemployed,} \end{cases} \tag{2}$$

Assumption (Single Index)

The probability of player i joining firm j at time t, $s_t^{i\to j}$ can be represented as a **single index function** $\mathcal{S}(\cdot) : \mathbb{R} \to [0,1]$ which is at least twice differentiable, always increasing ($\mathcal{S}'(x) > 0$), and which depends on the expected surplus

$$\Delta_t^{i\to j} = U_t^{i\to j} - \mathcal{O}_t^{i\to j}, \tag{3}$$

where $\mathcal{O}_t^{i\to j}$ represents the value (in utility) of the worker's outside-option.

Logit Competition [Anderson and de Palma, 1989]

$$s_t^{i\to j} = \frac{\exp(U_t^{i\to j})}{\exp(U_t^{i\to U}) + \sum_{k\in\mathcal{J}} \exp(U_t^{i\to k})} = \left[1 + \exp\left(-\left(U_t^{i\to j} - \mathcal{O}_t^{i\to j}\right)\right)\right]^{-1} \quad (4)$$

$$= \mathcal{S}\left(U_t^{i\to j} - \mathcal{O}_t^{i\to j}\right) \quad (5)$$

where $\mathcal{O}_t^{i\to j}$ takes the form of the expected maximum utility,

$$\mathcal{O}_t^{i\to j} = \ln\left[\exp\left(U_t^{i\to U}\right) + \sum_{k\in\mathcal{J}-\{j\}} \exp\left(U_t^{i\to k}\right)\right]. \quad (6)$$

Labor Demand

Firms profits given by:

$$\Pi_t^{i\to j}\left(w_t^{i\to j}\right) = \left(\underbrace{\exp\left(Y_t^{i\to j\prime}\delta\right)}_{\text{Marginal Product}} - w_t^{i\to j}\right)\underbrace{\mathcal{S}\left(X_t^{i\to j\prime}\beta + \alpha w_t^{i\to j} + \xi_t^{i\to j} - \mathcal{O}_t^{i\to j}\right)}_{\text{Pr. Accept Offer}} \tag{7}$$

Wage set by first-order condition:

$$w_t^{i\to j} = \exp\left(Y_t^{i\to j\prime}\delta\right) \underbrace{- \frac{\mathcal{S}\left(X_t^{i\to j\prime}\beta + \alpha w_t^{i\to j} + \xi_t^{i\to j} - \mathcal{O}_t^{i\to j}\right)}{\alpha\mathcal{S}'\left(X_t^{i\to j\prime}\beta + \alpha w_t^{i\to j} + \xi_t^{i\to j} - \mathcal{O}_t^{i\to j}\right)}}_{\text{Markdown}} \tag{8}$$

Modelling Collusion

Bidding cost paid to hire worker:

$$\Phi\left(C_t^{i\to j\prime}\gamma\right)\exp\left(Y_t^{i\to j\prime}\delta\right) \tag{9}$$

Wage given by:

$$w_t^{i\to j} = \exp\left(Y_t^{i\to j\prime}\delta\right)\left\{\underbrace{1-\Phi\left(C_t^{i\to j\prime}\gamma\right)}_{\text{Effective Discount}}\right\} - \frac{\mathcal{S}\left(X_t^{i\to j\prime}\beta + \alpha w_t^{i\to j} + \xi_t^{i\to j} - \mathcal{O}_t^{i\to j}\right)}{\alpha\mathcal{S}'\left(X_t^{i\to j\prime}\beta + \alpha w_t^{i\to j} + \xi_t^{i\to j} - \mathcal{O}_t^{i\to j}\right)}. \tag{10}$$

Goal: model how cartel increases bidding costs at beginning of collusive era.

C1. Should increase for workers in competitors' firms.

C2. Results in decreased mobility of these players.

C3. Lowers labor share of income and increases profits.

Econometric Strategy

Mobility: a match of worker i with firm j in year t is denoted by

$$\mathbb{1}_t(i \to j) = \begin{cases} 1 & \text{if } i \text{ joined firm } j \text{ in year } t, \\ 0 & \text{otherwise.} \end{cases}$$

Data: we observe (a) the worker-firm match, (b) the associated wage, measures of (c) productivity, (d) bidding costs, and (e) firm desirability.

$$\mathcal{D}_i := \left\{ \mathbb{1}_t(i \to j), w_t^{i \to j} \times \mathbb{1}_t(i \to j), Y_t^{i \to j\prime}, C_t^{i \to j\prime}, X_t^{i \to j\prime} \right\}_{t \in \mathcal{T}}^{j \in \mathcal{J}}. \tag{11}$$

Problem: cannot estimate labor supply by multinomial choice model.

1. Unobserved wages: who made what offer?
2. Unobserved attributes: what are the terms of contracts?

Cannot write the choice model of workers choosing among job offers.

Proposed Solution

Solution: labor demand equation is invertible under supermodularity assumption.

Remark (Offer Acceptance Probability)

$$s_t^{i\to j} = \mathcal{S}\left(\Gamma^{-1}\left[\alpha\left(\exp\left(Y_t^{i\to j\prime}\delta\right)\left\{1-\Phi\left(C_t^{i\to j\prime}\gamma\right)\right\}-w_t^{i\to j}\right)\right]\right. \tag{12}$$

Problem: Cannot use MLE because $s_t^{i\to j}(w_t^{i\to j})$ is unknown if no match.
Solution: d'Haultfoeuille [2010] shows identification with instruments.

Assumption (Identifying Restriction)

There exists *preference shifting instruments* $X_t^{i\to j}$ such that

$$\mathbb{1}_t(i\to j) \perp\!\!\!\perp X_t^{i\to j'} | w_t^{i\to j}, Y_t^{i\to j}, C_t^{i\to j}. \tag{13}$$

Estimation Generates unconditional moments used in GMM.

$$\mathcal{G}(\alpha,\delta,\gamma) = \mathcal{N}^{-1}\sum_{t\in\mathcal{T}}\sum_{i\in\mathcal{I}_t}\sum_{j\in\mathcal{J}_t}\left[\frac{\mathbb{1}_t(i\to j)}{s_t^{i\to j}}-1\right]'\left(Y_t^{i\to j\prime}, C_t^{i\to j\prime}, X_t^{i\to j\prime}\right). \tag{14}$$

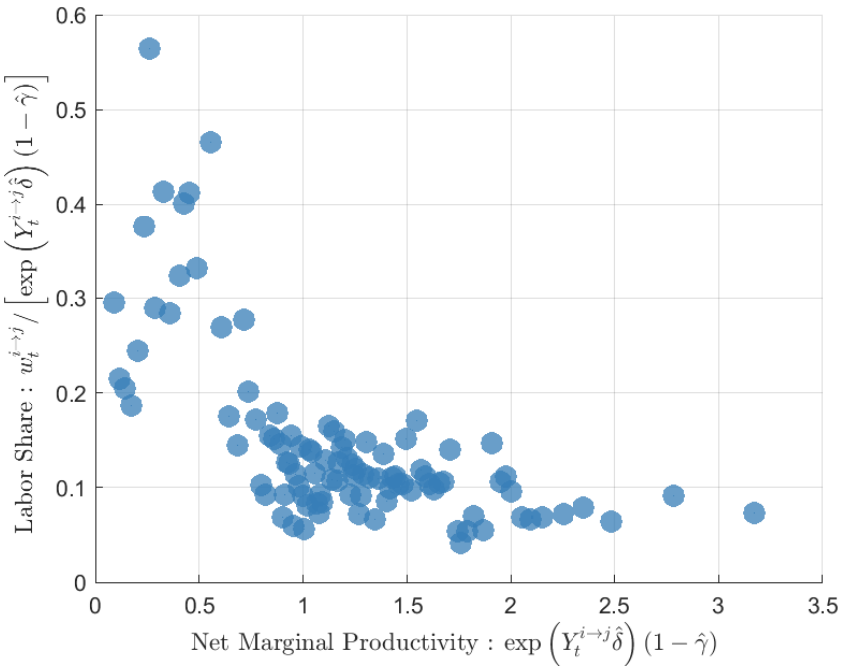
Application

- Model: Use a Gumbel probability model for $\mathcal{S}(\cdot)$ and logistic for $\Phi(\cdot)$.

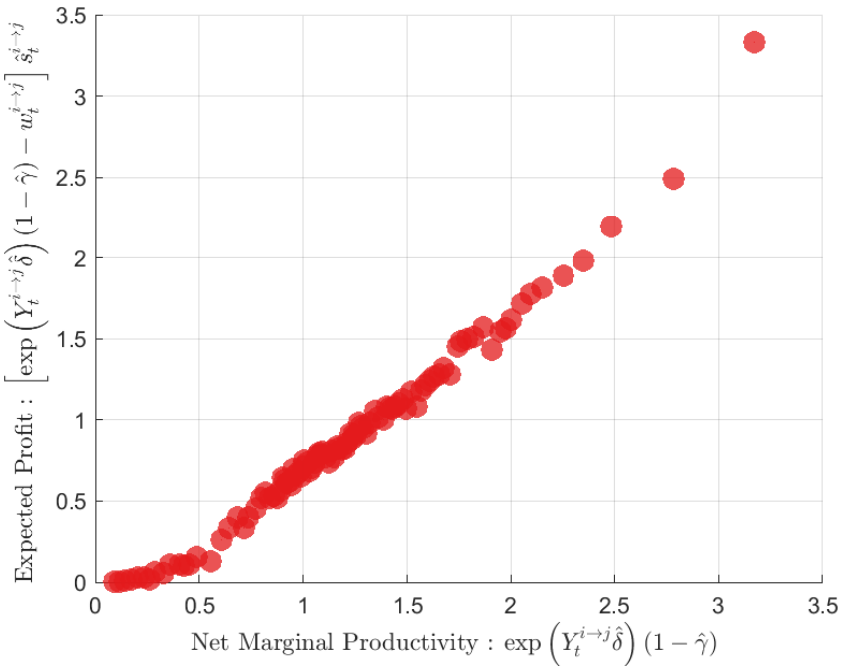
$$s_t^{i \to j} = \exp\left(- \left[\alpha \left\{ \exp\left(Y_t^{i \to j\prime} \delta \right) \left\{ 1 + \exp\left(C_t^{i \to j\prime} \gamma \right) \right\}^{-1} - w_t^{i \to j} \right\} \right]^{-1} \right)$$

- Marginal Productivity: year and team fixed effects, with performance variables specific to pitchers and hitters.
- Bidding Costs: experience, free-agency, and past-employer dummy.
  - Separate coefficients for pre-cartel, cartel, and post-cartel.
- Instrument by Home Bias: is player born in team's state + Share of "locals".

Model used to learn about labor market.



Labor Share

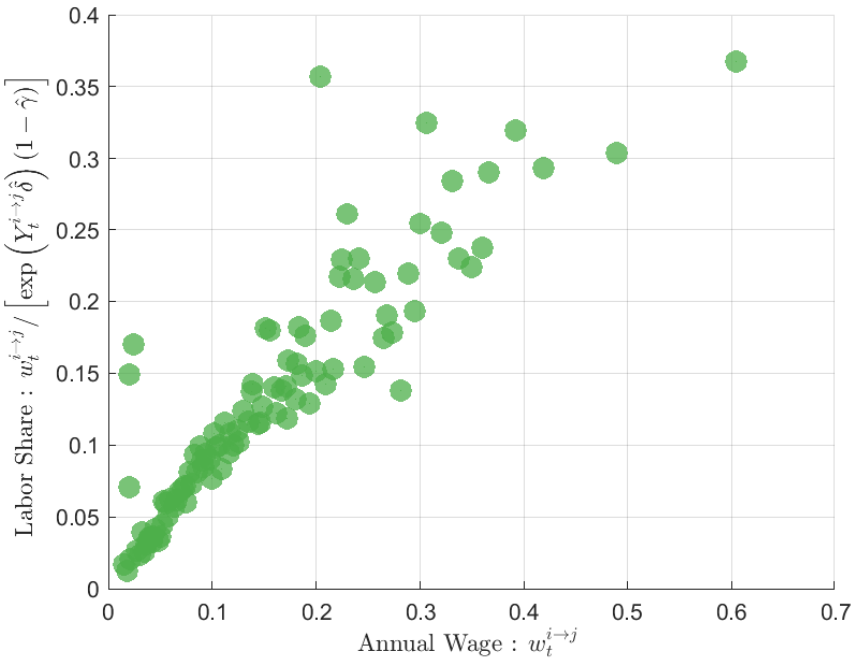


Expected Profits

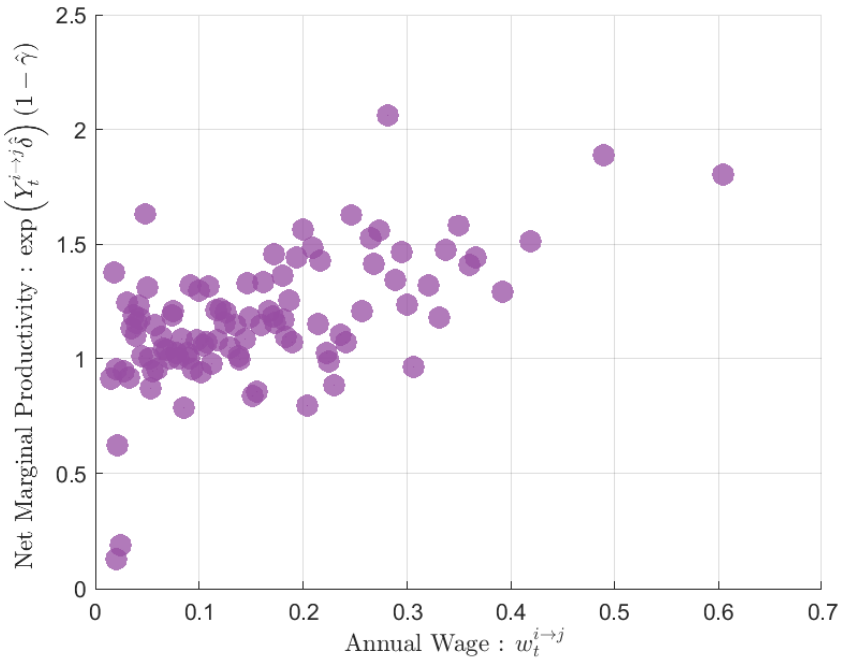
Figure: Labor Share and Profits v. Productivity (1982-5)

- Best players are not paid proportionately: most profitable for firms.
- High wage does not imply higher productivity.

Model used to learn about labor market.



Labor Share



Marginal Productivity

Figure: Labor Share and Productivity v. Wage (1982-5)

- Most well paid have high labor share.
- Correlation between wage and productivity is weak.

Collusive Evidence: Bidding Costs

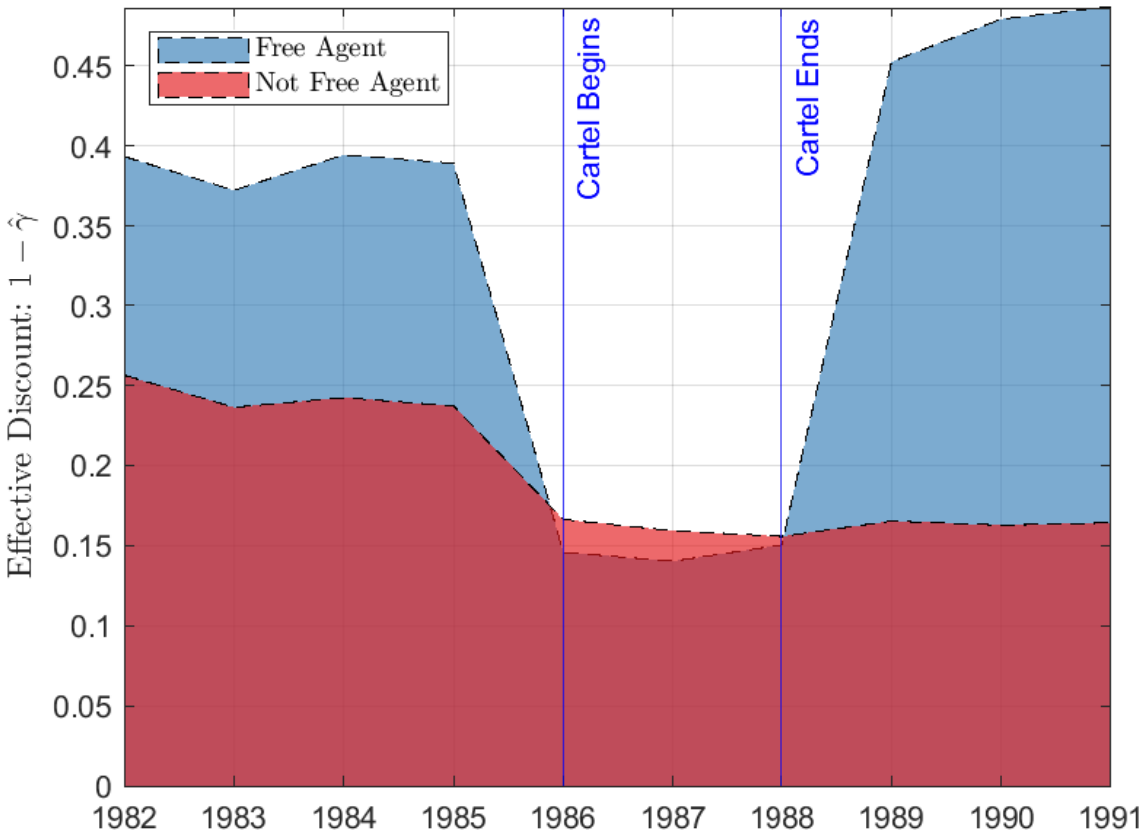


Figure: Bidding Costs of Free-Agents

- Effectively discounting the valuation of both free and non-free agents.

Collusive Evidence: Bidding Costs

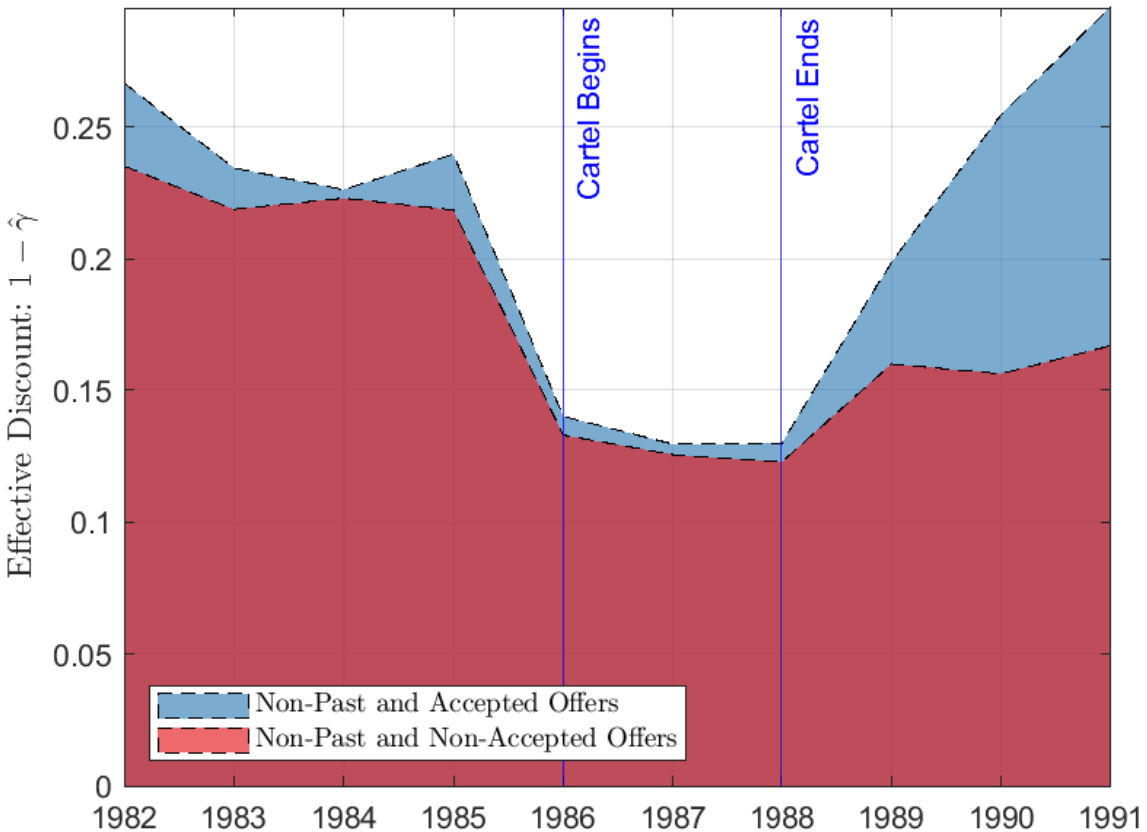


Figure: Bidding Costs of Accepted and Rejected Offers

- Effectively discounting non-past employees when bidding.

Collusive Evidence: Labor Share

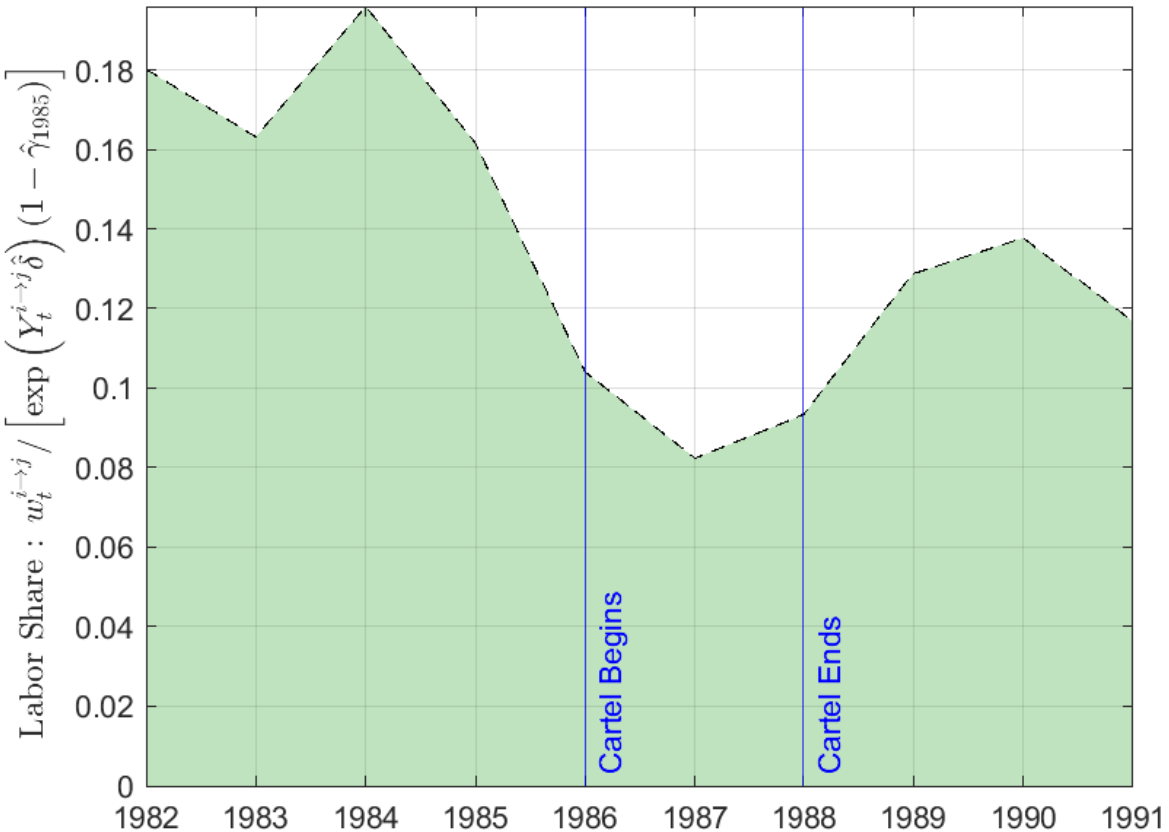
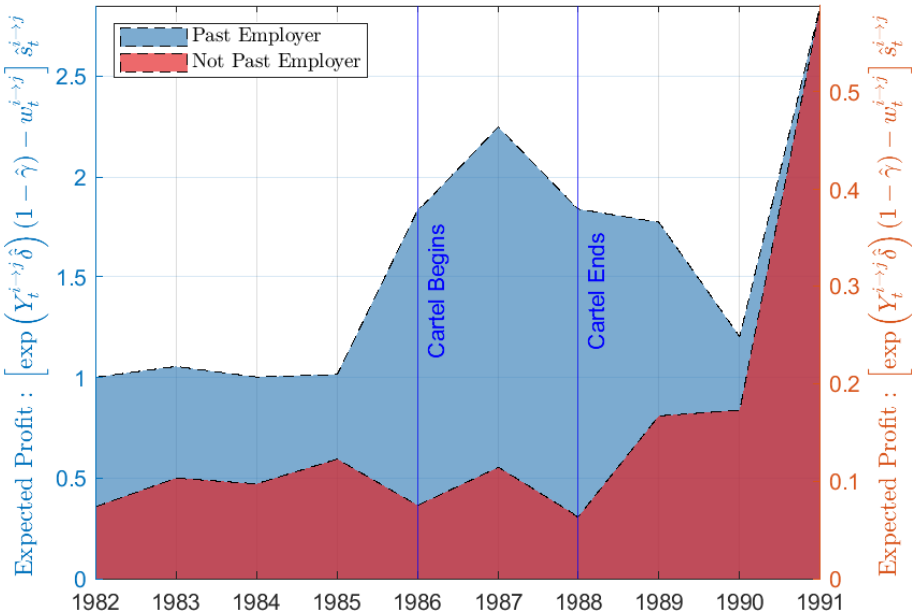


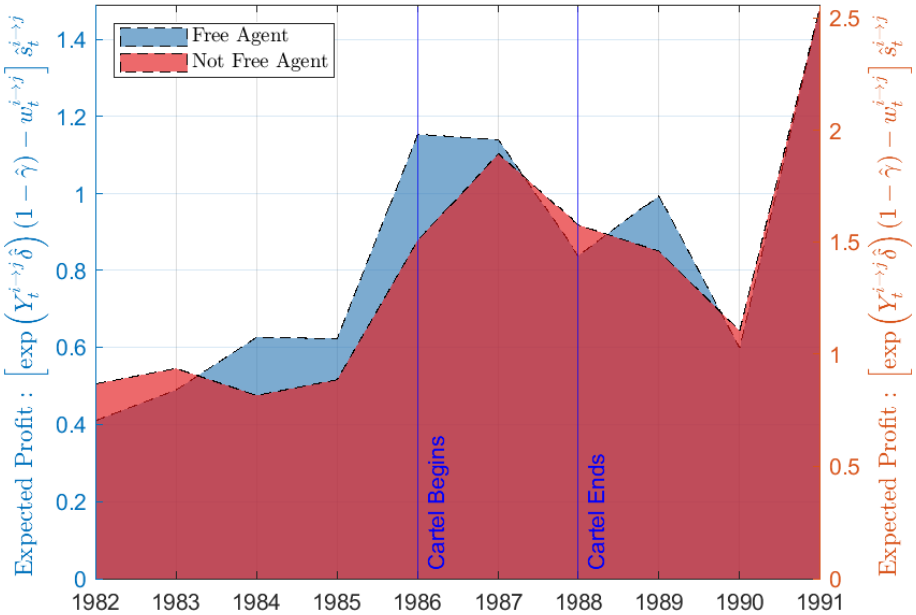
Figure: Labor Share of Income

- Fall in labor share of income : does not recover.

Collusive Evidence: Expected Profits



All Workers



Free-Agents

Figure: Expected Profits, Past Employer, and Free-Agents

- Profits mainly rise by hiring past-employees.
- Increase in profits from both free and non-free agents.

Simulating Deviation Wages

Each firm could deviate from collusion: keep outside-option fixed.

- Set wages assuming bidding costs are pre-cartel level.

$$\mathrm{D}(\mathrm{w}_t^{j\to j}) = \arg\max_w \left[\exp\left(Y_t^{j\to j\prime}\delta\right)\left(1-\Phi_{1985}^{j\to j}\right) - w\right]\mathcal{S}\left(\hat{\alpha}w + X_t^{j\to j\prime}\hat{\beta} + \hat{\xi}_t^{j\to j} - \hat{\mathcal{O}}_t^{j\to j}\right)$$

- Use the structural estimates to measure "gross" outside-option:

$$X_t^{j\to j\prime}\hat{\beta} + \hat{\xi}_t^{j\to j} - \hat{\mathcal{O}}_t^{j\to j} \equiv \hat{\Delta}_t^{j\to j} - \hat{\alpha}w_t^{j\to j}. \tag{15}$$

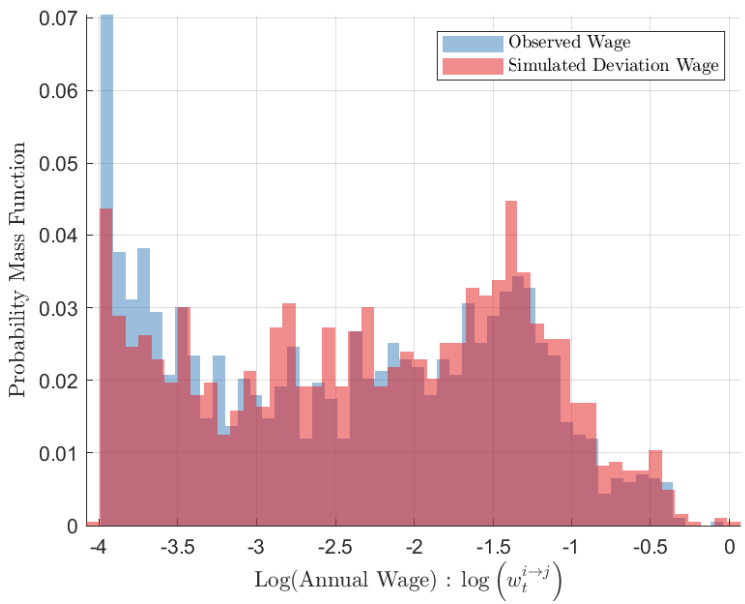
- Intuition: wage firm should have paid if free-rided on collusion of others.

- Note: lower bound wage as outside-option should be higher under competition.

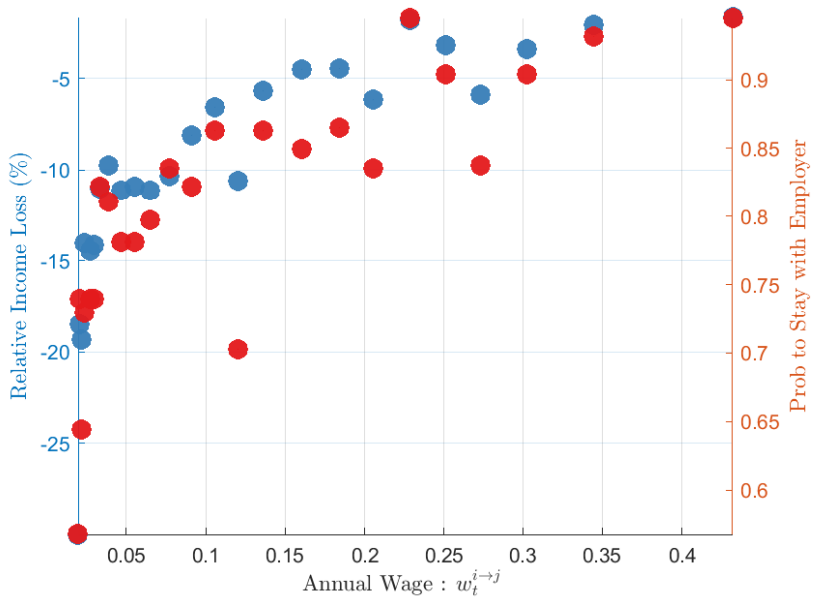
Simulating Deviation Wages: Results

	Mean	Std.	Q1	Med.	Q3	Min.
Relative Income Gain	31.19	102.17	0	0	0	-10.27
Relative Income Loss	-9.57	21.93	0	0	0	-92.52

- Average wage loss of at least 10% < 27% .
- Limited effect for immobile top-income.



Loss Histogram



Loss by Income Level

Conclusion

- Damage Quantification:
  - Inter-Percentile Differences-in-Differences.
  - Simple to implement, yet highly informative.
  - -27% yearly average loss of income from collusion in the MLB.
- Structural Model of Labor Market Competition:
  - Builds on Discrete Choice Model.
  - Learn about labor market (labor supply elasticity, labor share, profits).
  - Sudden change in wage, mobility, labor share, and profits indicative of collusion : heterogeneity depending on past-employee status.

Thanks!

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Summary and Discussion

Very general setup:

- Two supply chains with manufacturer (M) and retailer (R) : $M_i - R_i$.
- Asymmetric information: only retailers observe demand state $\theta = \{L, H\}$.
- Joint supply chain profit is non-parametric $\pi_{\theta i}(q_i, q_j)$:
  - U-shaped in q_i, strictly decreasing in q_j.
  - Regularity assumption : $\pi_{Hi}(q_i, q_j) > \pi_{Li}(q_i, q_j)$
  - Regularity assumption : $\nabla_{q_j}\pi_{Hi}(q_i, q_j) > \nabla_{q_j}\pi_{Li}(q_i, q_j)$
- Remark 1: Model consistent with horizontally differentiated products : can θ be interpreted as *vertical* differentiation?
- Remark 2a: Literature on asymmetric collusion in vertical markets : "A theory of hub-and-spoke collusion" (Sahuguet and Walckiers, IJIO 2017).
- Remark 2b: German coffee cartel (Holler and Rickert, IJIO, 2022): RPM?

Summary and Discussion

Manufacturer offers menu of two-part tariffs: $\{(q_{Hi}, T_{Hi}), (q_{Li}, T_{Li})\}$

- If retailer rejects both contracts, earns zero profit.
  - Remark 3: Assumption may drive up the opportunity cost of rejecting the menu. Could assume some "outside-profit" ℓ_i which induces some competition in monopoly manufacturer-retailer relationship (e.g, private label or sell some other product).

Potential industry structure in static (S) world:

- Symmetric Full-Information Monopoly (M): retailers reveal θ to manufacturer, quantities maximize joint-profits.
- Asymmetric Information with Competition: punishment contract such that
  - ⋆ Retailer accepts low-type contract (IR)
  - ⋆ Retailer prefers high-type contract over low-type if $\theta = \text{H}$.

Summary and Discussion

Collusion and dynamics:

- Collusion: firms can discount future profits at rate δ.
- Requires dynamic incentive contracts:
  - ⋆ Manufacturer prefers colluding over one-off deviation + punishment contract (IC_M).
  - ⋆ Retailer prefers to continue colluding in $\theta = L$ rather than get zero + punishment (IR).
  - ⋆ Retailer does not take L with $\theta = H$ + punishment (IR).
- Corollary 1: if $\pi_{Hi}(q_L^M, q_H^M) - \pi_{Li}(q_L^M, q_L^M) > \pi_{Hi}(q_L^S, q_H^S) - \pi_{Li}(q_L^S, q_L^S)$
  - ⋆ Manufacturers benefit from including the retailers in collusion.
- Remark 4: This is relative to playing the asymmetric information competitive equilibria. Could exclusionary collusion with just manufacturers be a better threat? Would be plausible presumably (for p»0) and damaging.

Other remarks

Open questions:

- Can the model be reverted with manufacturer observing the market demand but retailers setting menus (e.g, Apple selling iPods through supermarkets).
- Quantity distortions: can something be said for consumer surplus ?
- Cartel deterrence : how does a probability q of cartel detection with fines (F_M, F_R) affect collusive stability?
- Would be nice to see, if possible, a graphical representation of stability v. profitability of collusive agreement.

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