Are Markups Too High? Competition, Strategic Innovation, and Industry Dynamics

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Motivation

In the last four decades, the U.S. witnessed significant changes in firm dynamics within and across industries, with aggregate implications.

- **The Rise of Superstar Firms:** Industries are increasingly dominated by a small number of large firms. (Autor et al. (2017, 2019), Gutierrez and Philippon (2016), ...)
- **Rising Markups, Profits, and Market Concentration:** Barkai (2016), De Loecker and Eeckhout (2018), De Loecker, Eeckhout, and Unger (2019), Gutierrez and Philippon (2017), ...

Motivation

- **Decline in the Labor Share:** Elsby, Hobijn, and Sahin (2013), Karabarbounis and Neiman (2013), ...
- **Decline in Business Dynamism:** Decker, Haltiwanger, Jarmin, and Miranda (2016), Hathaway and Litan (2014), Pugsley and Sahin (2018), ...
- **Slowdown in Productivity Growth:** TFP growth is declining, despite the increase in R&D spending. (Bloom, Jones, Van Reenen, and Webb (2020), Gordon (2012, 2014))

Questions

- What are the economic mechanisms that underlie this structural transition?
- What are the implications for efficiency, economic growth, and social welfare?
- We need a unified framework to address these questions.

This Paper

We develop a model:

- Can explain the aggregate trends.
- With rich industry dynamics:
  - Oligopolistic competition (Cournot).
  - Endogenous number of superstar firms.
  - Endogenous mass of small firms.
  - Endogenous new business creation by entrepreneurs.
  - Endogenous entry and exit.
- With endogenous productivity growth:
  - Superstars innovate to improve their productivity.
  - Small firms innovate to become superstars.
  - Strategic interactions.
- Consistent with facts on competition and innovation:
  - Across industries: Inverted-U relationship between innovation and HHI.
  - Within industries: Inverted-U relationship between firm innovation and market share – new empirical fact.

Other Frameworks with Endogenous Markups

	Competition	Productivity growth	Nb. of firms
Oligopolistic Competition with Exog. Productivity	Cournot (CES)	Exogenous (AR(1))	N (out of M) active firms
Monopolistic Competition with One-Time Investment	Monopolistic (Kimball)	One-time investment at $t = 0$	1 firm
Step-by-Step Endog. Growth Models	Bertrand (homogeneous)	Step-by-step innovation	1 or 2 active firms
Monopolistic Endog. Growth Models	Bertrand (homogeneous)	Incumbent and/or Entrant	1 active firm
This paper	Cournot (CES) with competitive fringe of small firms	Endogenous innovation by all firms	N superstars, mass m of small firms

- Only our paper can match the inverted-U relationships – key for the counterfactual response of economic growth to competition.

Overview of Findings

- Decline in the relative productivity of small firms is found to be responsible for:
  - The increase in markups and profits.
  - The decline in the labor share.
  - The rise of the superstars.

- The welfare impact, however, is **positive**:
  - Static losses from higher markups: -3.73%
  - Dynamic gains from higher innovation: 8.25%
  - **Total gain**: 4.52%
  - $\Rightarrow$ Dynamic effects should not be ignored.

- The observed decline in productivity growth is due to the decline in R&D efficiency:
  - "Ideas are getting harder to find"? Inefficiencies?

Model

Production: Industry Production

- Each industry is composed of
  1. An endogenous number ($N_{jt} \leq \bar{N}$) of superstar firms producing $\{y_{ijt}\}_{i=1}^{N_{jt}}$
  2. A competitive fringe composed of mass m_t of small firms producing $\tilde{y}_{cjt} = \int y_{ckjt} \, dk$

- Industry production is given by:

$$y_{jt} = \left(\sum_{i=1}^{N_{jt}} y_{ijt}^{\frac{\eta-1}{\eta}} + \tilde{y}_{cjt}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

Production: Variety Production

- Each superstar firm in an industry has a productivity q_{ijt}.
- Each small firm in the fringe has productivity $q_{cjt} = \zeta q_{jt}^{leader}$.
- ζ: Relative productivity of the small firms.

- Linear production technology: $y_{ijt} = q_{ijt} l_{ijt}$
- Superstar firms compete *à la* Cournot.
- Small firms in the competitive fringe are price takers.

R&D, Productivity Growth, and Entry and Exit of Superstars

- Superstar firms pay a cost $R_{ijt} = \chi z_{ijt}^{\phi} Y_t$ to create a Poisson arrival rate z_{ijt} of increasing their productivity by step size λ.

- If a superstar firm falls more than $\bar{n}$ steps below the leader, it exits the set of superstar firms, and becomes a small firm.

- Small firms in the fringe can pay a cost $R_{ekjt} = \nu X_{kjt}^{\epsilon} Y_t$ to create a Poisson arrival density X_{kjt} of becoming a superstar with productivity $q_{ijt} = \frac{q_{jt}^{leader}}{(1+\lambda)^{\bar{n}}}$.

- Superstar entry rate is heterogeneous across industries j; depends on endogenous industry characteristics.

▸ How large are the superstars that exit?

Entrepreneurs, and Entry and Exit of Small Firms

- The mass of small firms is also endogenous.
- Mass one of entrepreneurs can pay a cost $\psi e_t^2 Y_t$ to create a Poisson arrival rate e_t of founding a new small business.
- Exogenous exit of small firms: τ

$$\dot{m}_t = e_t - \tau m_t$$

Static Equilibrium in the Product Market

- We can solve for the static Cournot equilibrium in each industry j.
- Delivers non-degenerate distribution of sales, profits, markups, etc.
- Only need to keep track of the number of superstar firms, N, and their relative productivities, $\mathbf{n}$. $\Rightarrow$ Industry state: $\Theta \equiv (\mathbf{n}, N)$.

Details

Superstar Value Function

Many scenarios to take into account in the dynamic problem:

$$\rho V(\mathbf{n}_i, N) = \max_{z_i} \underbrace{\pi(\mathbf{n}_i, N)}_{\text{Profit flow}} - \underbrace{\chi z_i^{\phi} Y}_{\text{R\&D cost}}$$

$$+ \underbrace{z_i \left[V(\mathbf{n}_i \backslash \{n_i^k = \bar{n}\} + \mathbf{1}, N - |\{n_i^k = \bar{n}\}|) - V(\mathbf{n}_i, N) \right]}_{\text{Own innovation – can cause other superstars to exit}}$$

$$+ \underbrace{\sum_{k: n_i^k = -\bar{n}} z_{kj}(0 - V(\mathbf{n}_i, N))}_{\text{Others' innovation – firm } i \text{ exits}}$$

$$+ \underbrace{\sum_{n_i^k \neq -\bar{n}} z_{kj} [V(\mathbf{n}_i \backslash \{n_i^k; n_i^l = \bar{n} + n_i^k\} \cup \{n_i^k - 1\}, N - |\{n_i^l = \bar{n} + n_i^k\}|) - V(\mathbf{n}_i, N)}_{\text{Others' innovation - no exit}}$$

$$+ \underbrace{X_j \left[V(\mathbf{n}_i \cup \{\min\{\bar{n}, \bar{n} + \min(\mathbf{n}_i)\}\}, \min(N+1, \bar{N})) - V(\mathbf{n}_i, N) \right]}_{\text{Entry of a new superstar – a small firm successfully innovates}}$$

Small Firm's Dynamic Problem & Entrepreneur's Problem

- Given the expected value of becoming a new superstar, small firms in each industry choose their R&D X_{kjt}. (Heterogeneous across industry-states.)
- Given the expected value of founding a new small firm, the entrepreneurs choose the rate of new business creation e_t.
- We can solve for the BGP equilibrium, as well as non-stationary equilibria with transition.

Details

Relationship Between Competition and Innovation

Competition and Innovation

- The relationship between competition and innovation is **non-linear**.
  - Positive: Innovate more to escape competition.
  - Negative: Competition reduces expected profits.
- **Across industries:** Industry innovation is hump-shaped in market concentration.
  - Not a new finding: Aghion et al. (2005).
- **Within industries:** Firm innovation is hump-shaped in market share.
  - To our knowledge, a new empirical fact.
- Please see our draft for the full empirical findings and their robustness.

Empirics

Quantitative Analysis

Estimation

- External calibration: $\rho = 0.04$.
- Internal estimation: 9 parameters, 11 targets.
- Three samples: 1976-2004, 1976-1990, 1991-2004.

A. Parameter estimates

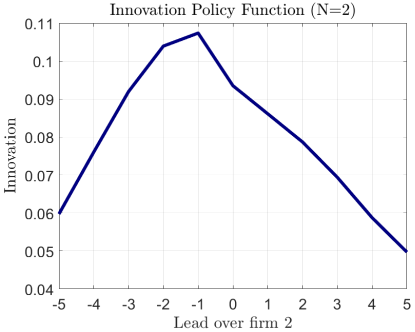
Parameter	*Description*	*Whole sample*	*Early sample*	*Late sample*
λ	innovation step size	0.3126	0.3369	0.3261
η	elasticity within sector	6.6800	16.5759	6.9717
χ	superstar cost scale	120.5659	198.7544	73.1135
ν	small firm cost scale	3.4046	1.3209	2.5502
ζ	competitive fringe ratio	0.5912	0.616	0.5454
ϕ	superstar cost convexity	3.8711	4.1409	3.3975
ϵ	small firm cost convexity	2.6594	2.8913	2.5583
τ	exit rate	0.1151	0.1257	0.1052
ψ	entry cost scale	0.0149	0.0079	0.0115

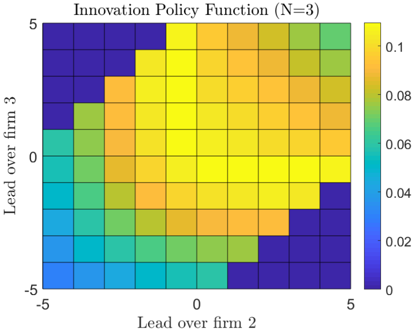
Target Moments

B. Moments

Target moments	Whole sample Data	Whole sample Model	Early sub-sample Data	Early sub-sample Model	Late sub-sample Data	Late sub-sample Model
growth rate	2.20%	2.20%	2.42%	2.42%	1.98%	1.98%
R&D intensity	2.43%	2.02%	2.38%	1.86%	2.50%	2.33%
average markup	1.3498	1.3462	1.2805	1.2801	1.4242	1.4195
stdv markup	0.346	0.387	0.299	0.319	0.396	0.428
labor share	0.652	0.628	0.656	0.630	0.648	0.611
entry rate	0.115	0.115	0.126	0.126	0.105	0.105
β(innovation, relative sales)	0.629	0.726	0.435	0.682	0.699	0.756
top point (intra-industry)	0.505	0.448	0.447	0.470	0.507	0.453
average profitability	0.144	0.176	0.137	0.153	0.147	0.204
average leader relative quality	0.749	0.642	0.750	0.621	0.747	0.643
stdv leader relative quality	0.223	0.161	0.224	0.145	0.222	0.149

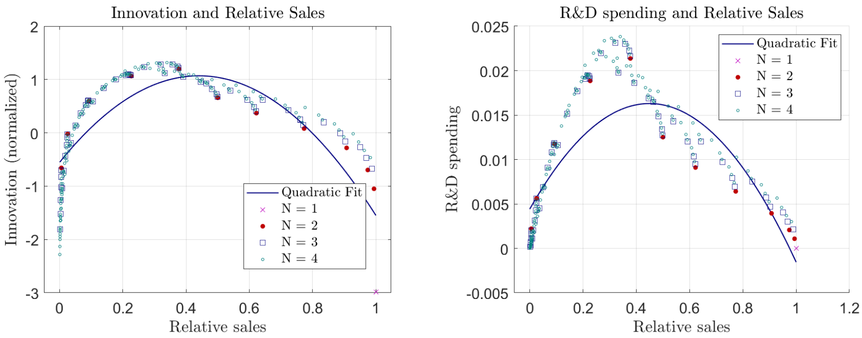
Innovation Policy Functions





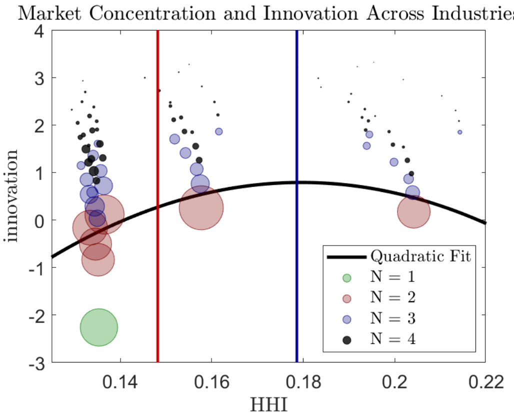
- Innovation policy depends on the relative quality of the competitors.
- Estimated economy: innovation is higher when the difference is low.
- This is not driven by modeling assumptions: We can generate a U-shape with different parameters.

Model: Firm Innovation and Relative Sales



- Both innovation and R&D spending are hump-shaped in relative sales.
- This is true across all firms, as well as industries with the same number of superstar firms.

Model: Industry Innovation and Market Concentration



- Red line: Average HHI in the estimated economy.
- Total innovation is decreasing in competition for most industries.
- $\Rightarrow$ Critical for effects of competition on economic growth.

Disentangling the Structural Transition

Over the time period:

1. Small firms become less productive (lower ζ).
2. R&D costs for both small and large firms go up.

- (1) increases markups, decreases the labor share, but **increases** growth and welfare.
- (2) lowers growth and welfare.

- Please see the paper for the remaining (less impactful) changes.

▸ η ▸ ζ ▸ ν and ϵ ▸ χ and ϕ ▸ ψ and τ ▸ All ▸ Distribution

Static vs. Dynamic Effects of Higher Markups

- Higher markups ⇒ Lower static efficiency ⇒ Lower welfare.
- Higher profits ⇒ Higher incentives to innovate ⇒ Higher growth and welfare.

Decomposition of the C.E. Welfare Change	Static Effects (Short-run)	Dynamic Effects (Long-run)
competitive fringe prod.	-12.94%	-12.94%
relative wage	5.81%	6.05%
output of superstars	2.50%	2.77%
consumption/output	0.00%	-0.92%
output growth	0.00%	8.30%
total	**-3.73%**	**4.52%**

- A model without endogenous productivity dynamics would find **losses** instead of gains (-3.73% vs. 4.52%).
- **Social planner's problem:** Under-investment in innovation is 4 times more severe than the under-production due to market power in the decentralized equilibrium. ⇒ Consistent with the result.

Distributional Implications of Higher Markups

- The increase in markups due to the fall in ζ has heterogeneous welfare implications for workers vs. capitalists.

	CEWC
Representative household	4.52%
Workers	-0.70%
Capitalists	24.39%

- The gains from higher growth accrue mostly to the capitalists.
- The workers are slightly worse off – higher wage growth, but lower labor share.
- Redistribution?
- Boar and Midrigan (2019).

Declining R&D Efficiency of Small and Large Firms

- Small firm R&D costs go up $\Rightarrow$ Welfare loss: **6.38%**
  - "Gazelles" getting rarer (Pugsley, Sedlacek, and Sterk (2018)).
- Superstar R&D costs go up $\Rightarrow$ Welfare loss: **17.88%**
  - "Ideas are getting harder to find"? (Bloom et al. (2020)).
  - Stronger IPR, increased patent litigation, protective patents. (Han (2018), Galasso and Schankerman (2014), Argente et al. (2020)).
  - Higher misallocation of talent in innovation? (Celik (2017)).
- Increasing markups are not the culprit behind the productivity slowdown; declining R&D efficiency is.

Model Validation

The estimated model matches several non-targeted patterns, qualitatively and quantitatively:

- Increase in productivity dispersion (Barth et al., 2016)
- Gouin-Bonenfant (2018): negative correlation between industry-level labor share and productivity dispersion
- Negative correlation between firm-level labor share and value-added (Autor et al., 2019, Kehrig and Vincent, 2017 and Gouin-Bonenfant, 2018)
- Increase in the market share of superstar firms (Autor et al., 2019)
- Negative association between change in labor share and change in market concentration (Autor et al., 2019)
- Entry into superstars and market concentration

Robustness Checks

- **Elasticity of Intertemporal Substitution:** We replace the log utility with CRRA. The results are robust.
- **Exogenous Growth:** We attribute only half of the observed growth to innovation. The results are robust.
- **Capital Accumulation:** We add physical capital accumulation into the model. The results are robust.
- **Sensitivity to Markup Estimates:** Our results are robust to using cost-weighted markups, or not relying on any markup-based data moments.
- **Transition Dynamics:** Despite 86 continuous state variables to keep track of, we can calculate non-stationary equilibria without any deviation from rational expectations. The results are robust.

Markup sensitivity Transition dynamics

Tractability and Extensions

- The model, despite its rich dynamics, is easy to compute and extend.
- Two extensions we are working on:
  - Adding an **M&A** superstructure to study the dynamic effects of antitrust policy on growth and welfare.
  - Introducing **advertising** as another margin for the firms to compete in, and assessing how it interacts with firm innovation.
- We are hopeful that it can serve as a baseline for future work that focuses on industry dynamics, given its tractability.

Conclusion

Conclusion

Two main take-aways:

- Should we be worried about the rise in markups? Not necessarily!
  - Dynamic gains from growth dominate the static losses from markups.
  - However, the gains are not equally distributed due to wealth inequality.
  - Policy: More redistribution?
- Falling R&D efficiency is behind the productivity slowdown.
  - Especially true for superstar innovation.
  - More research is needed to find out why.
  - Policy: Higher and targeted R&D subsidies?