Product Differentiation, Oligopoly, and Resource Allocation

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Income Distribution and Macroeconomics

The Welfare Costs of Oligopoly

Old and recurring question in economics:

- Harberger (1954): misallocation *across* industries
- Empirical I.O. (1980s-today): *within* industry

Resurgent interest with a macro angle (Syverson, 2019). Trends:

- Rising corporate profits (Barkai, 2020)
- Rising concentration: (Autor et al., 2020)
- Markups distribution shifting (De Loecker & Eeckhout, 2020)

Question: what are the welfare implications of rising concentration?
→ Change in oligopolistic deadweight loss and consumer surplus.

This Paper

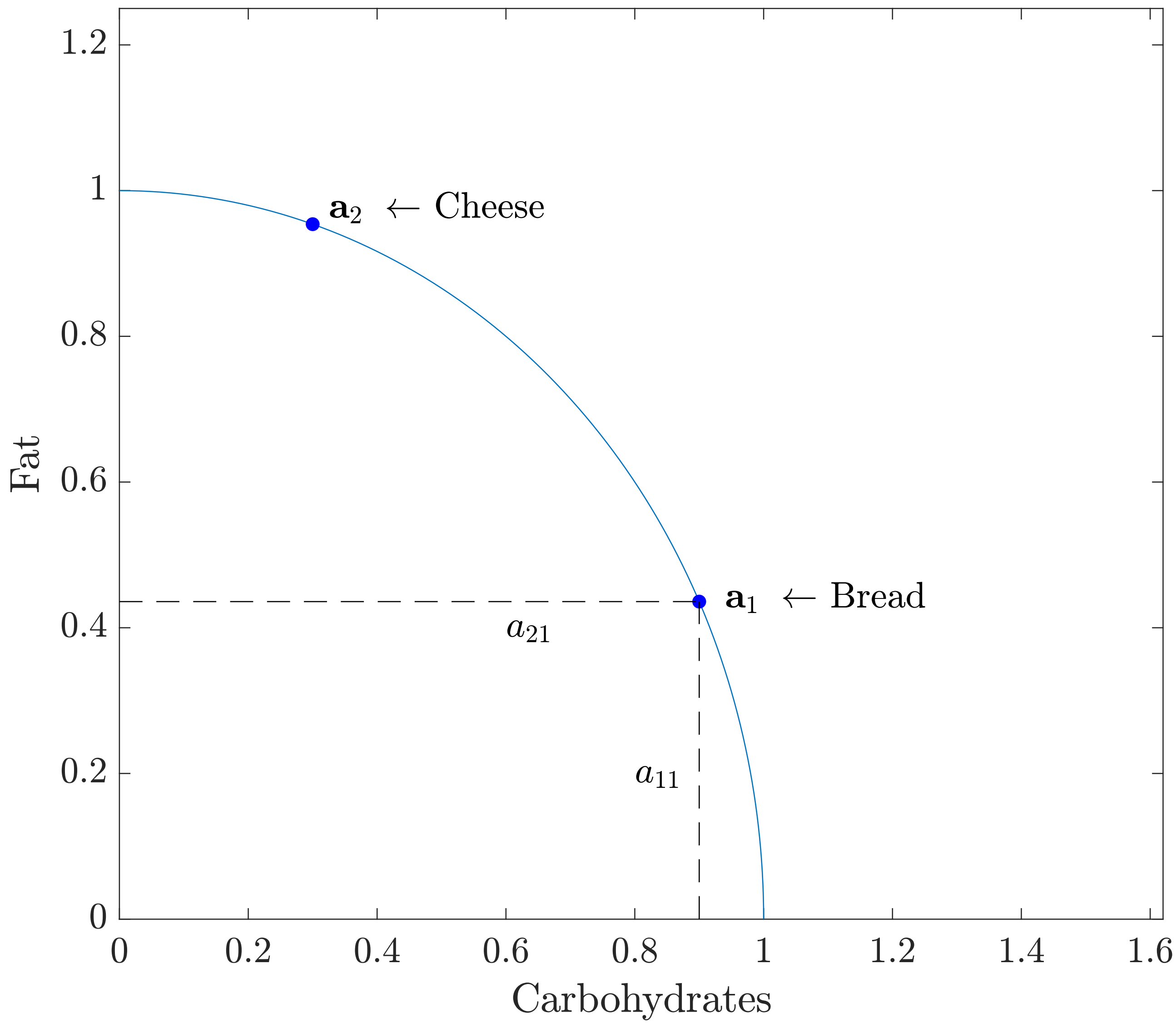
- I.O.-style general equilibrium model that features *granular* firms that behave as oligopolists alongside a continuum of atomistic firms with free entry that act competitively.
- **Hedonic demand** to model competition among oligopolists.
- I estimate it for the universe of US public companies using bilateral product similarity scores by Hoberg & Phillips (2016)
- **Results**: rising concentration resulted in 30%+ deadweight loss, consumer share of surplus declining from 50% to 44%.
- **Contribution**: connects I.O. to a growing macro literature on markups (Baqaee & Fahri, 2020; Edmond, Midrigan & Xu, 2019) to answer questions about oligopoly in macro/GE environment.

The Model

Supply structure

- $i = 1,2,\ldots,n$ firms that behave as oligopolists (will explain later how to incorporate atomistic firms).
- Hedonic demand: each firm's product is a bundle of characteristics (Lancaster, 1968; Rosen, 1974)
- 1 unit of product i provides:
  - 1 unit of an idiosyncratic characteristic i
  - a unit-length vector $\mathbf{a}_i$ of k common characteristics

A basic example: 2 firms, 2 characteristics



Aggregating common characteristics

Characteristics (Nutrient Intake)		**Matrix of Coordinates (Nutrition Facts)**	**Product Bundle**

$$\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_k \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{k1} & a_{k2} & \cdots & a_{kn} \end{bmatrix} \begin{bmatrix} q_1 \\ q_2 \\ \vdots \\ q_n \end{bmatrix}$$

$$\mathbf{x} = \mathbf{A}\mathbf{q}$$

Representative agent utility

- Representative consumer values products as bundles of characteristics $U(\mathbf{x},\mathbf{q},H) =$

$$\alpha \cdot \sum_{j=1}^{k} \left(b_j^x x_j - \frac{1}{2} x_j^2 \right) + (1-\alpha) \sum_{i=1}^{n} \left(b_i^q q_i - \frac{1}{2} q_i^2 \right) - H$$

- H = hours worked – numeraire
- Because $\mathbf{x} = \mathbf{A}\mathbf{q}$, this can be re-written in term of $\mathbf{q}$
- Consumer faces price vector $\mathbf{p}$ and choose $\mathbf{q}$

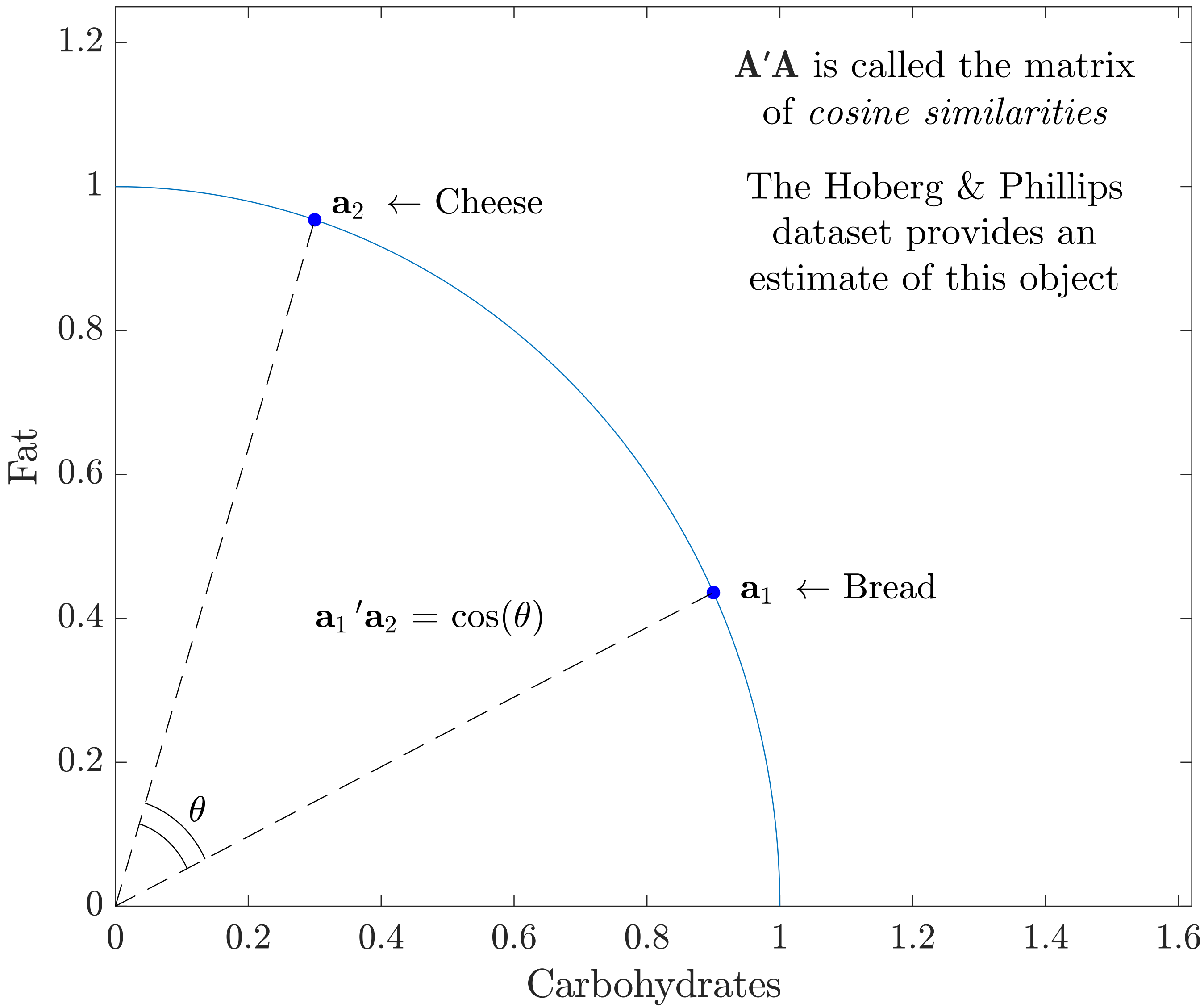
Inverse Demand

$$\mathbf{p} = \mathbf{b} - (\mathbf{I} + \mathbf{\Sigma})\,\mathbf{q}$$

where

$$\mathbf{\Sigma} \stackrel{\text{def}}{=} \alpha\,(\mathbf{A}'\mathbf{A} - \mathbf{I})$$

Back to 2 firms, 2 characteristics

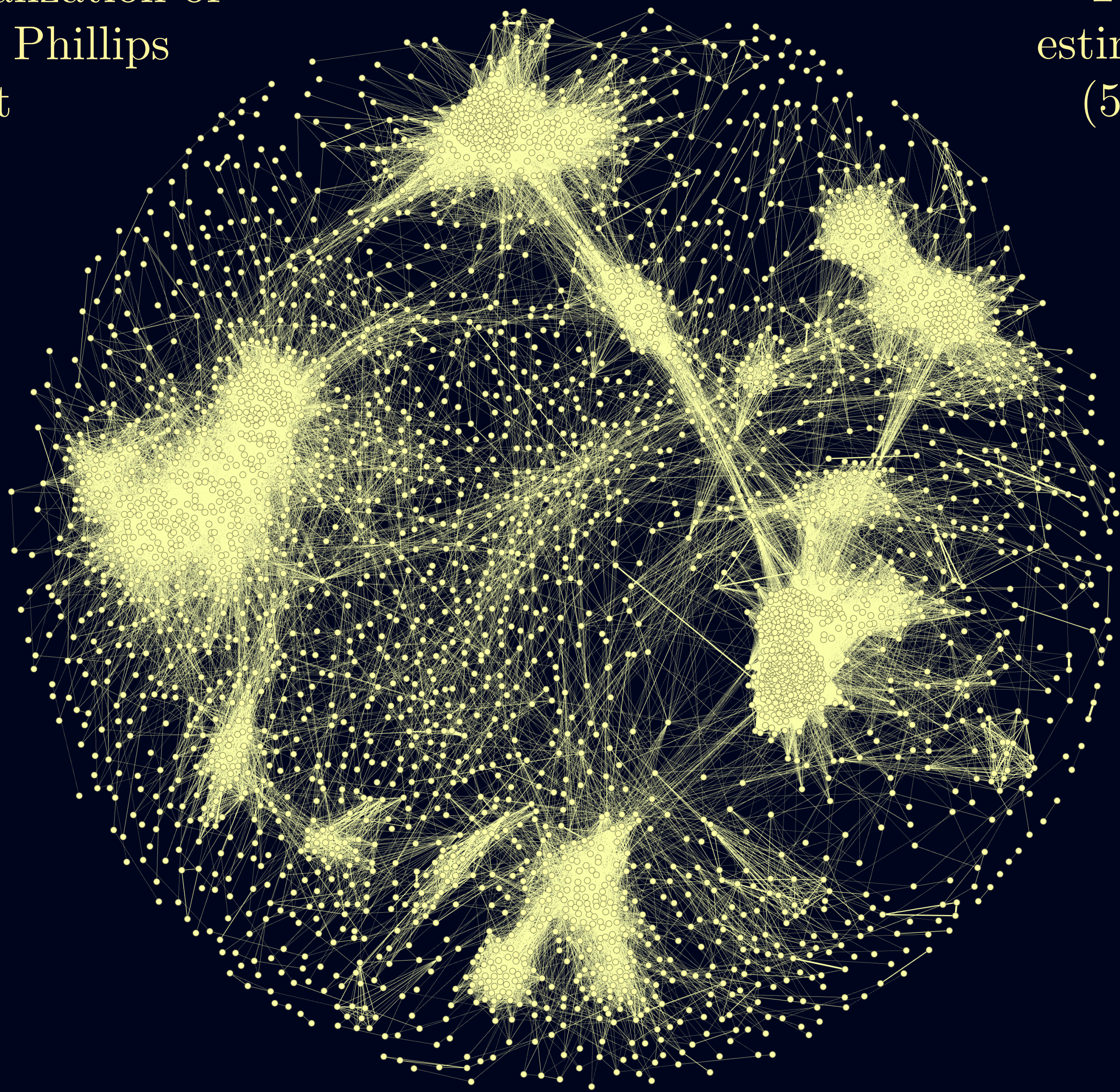


Competition

- Cost function: $$h_i = c_i q_i + \frac{\delta_i}{2} q_i^2$$
- Cournot Competition: firm i choose supply q_i to maximize profits π_i (quadratic)
- Linear-quadratic game over a weighted network (Ballester, Calvó-Armengol & Zenou, 2006)
- Why? Σ (the matrix of inverse demand derivatives) can be seen as an adjacency matrix of a network

Network visualization of the Hoberg & Phillips (2016) dataset

Time-varying estimate of A'A (5000×5000)



Nash Equilibrium (Katz-Bonacich Centrality)

$$\mathbf{q} \stackrel{\text{def}}{=} \left(2\mathbf{I} + \mathbf{\Delta} + \mathbf{\Sigma}\right)^{-1} \left(\mathbf{b} - \mathbf{c}\right)$$

Scale Economies ($\mathbf{\Delta}$) — Network Position ($\mathbf{\Sigma}$) — Marginal Surplus at $q_i = 0$ ($\mathbf{b} - \mathbf{c}$)

Equilibrium size depends on:

- Producing at low cost relative to quality
- Being “far” from competitors (centrality)

Adding a continuum of atomistic firms with entry/exit

- We can tractably fit a demand system for US public firms (new). Can we include private and foreign firms, and allow free entry?
- **Problem**: Hoberg-Phillips only covers US public firms.
- **Idea**: use a representative firm to model other firms as atomistic.
- **Aggregation Result**: if the atomistic firms' cost function is quadratic and the productivity distribution tends to a Zipf Law the representative firm's cost function is quadratic in the limit.
- Implies that revenues and employment also follow a Zipf Law.
  - Holds almost perfectly in US Census data (Axtell, 2001)

Equilibrium with representative competitive firm

Cournot: $$\mathbf{q} = (2\mathbf{I} + \mathbf{\Delta} + \mathbf{\Sigma})^{-1} (\mathbf{b} - \mathbf{c})$$

Modifies to: $$\mathbf{q} = (\mathbf{I} + \mathbf{G} + \mathbf{\Delta} + \mathbf{\Sigma})^{-1} (\mathbf{b} - \mathbf{c})$$

Where:

$$\mathbf{G} = \begin{bmatrix} 1 & 0 & \cdots & 0 & 0 \\ 0 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 1 & 0 \\ 0 & 0 & \cdots & 0 & 0 \end{bmatrix}$$

Data - Hoberg & Phillips (2016)

- They construct similarity scores by text mining the "Business Description" section of 10-K filings; already standard in Finance.

- Solve long-standing problems with NAICS/SIC: binary, arbitrary, easily manipulated, based on process (not product) similarity, seldom updated. SEC filings must be accurate and complete.

- Construction:

$$\mathbf{o}_i = \begin{bmatrix} o_{i,1} \\ o_{i,2} \\ \vdots \\ o_{i,61146} \end{bmatrix}, \qquad \mathbf{a}_i = \frac{1}{\|\mathbf{o}_i\|} \cdot \mathbf{o}_i$$

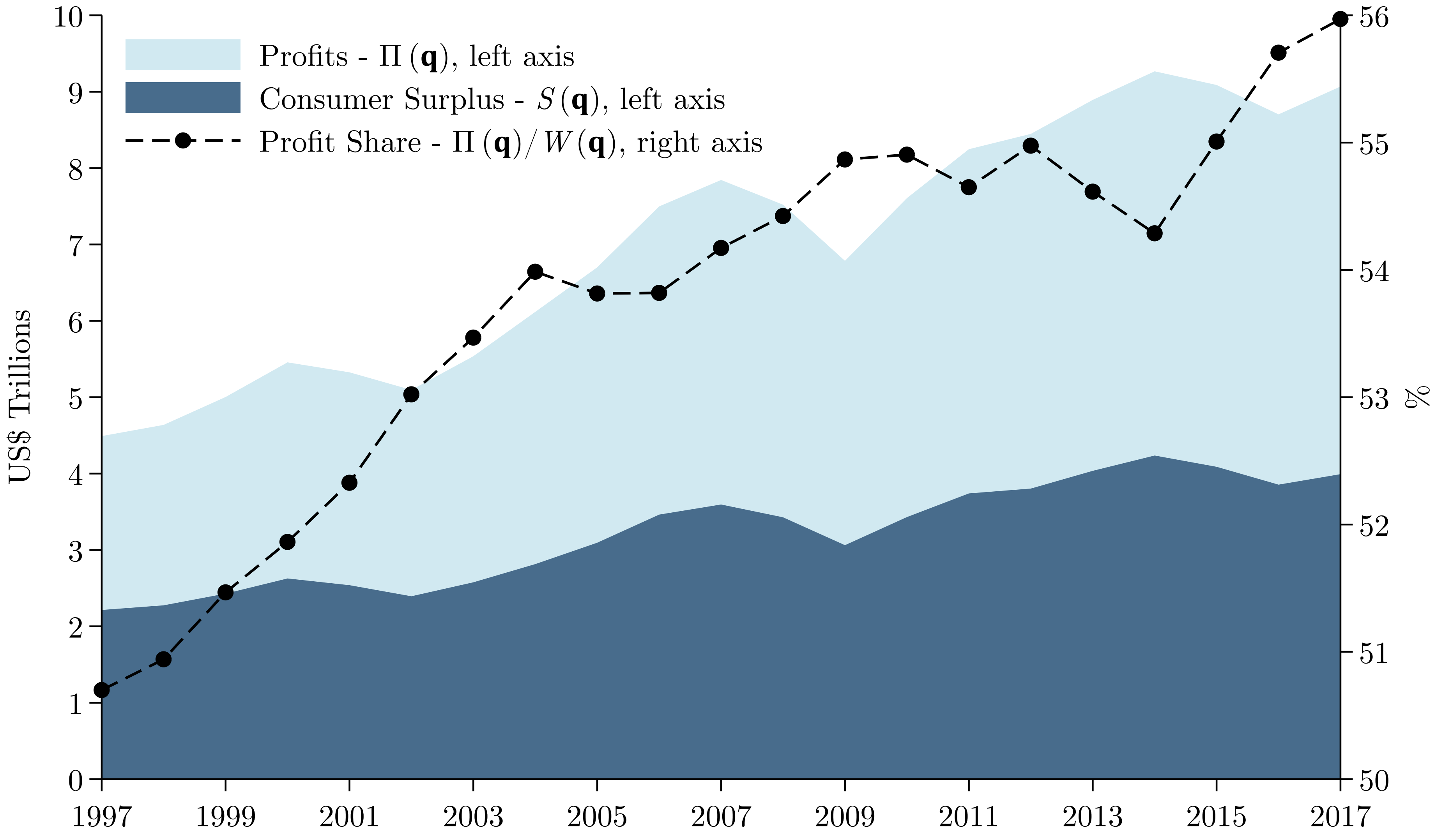
Validation / Calibration

Both my paper and the original HP paper validate the text data extensively (for more details see the papers)

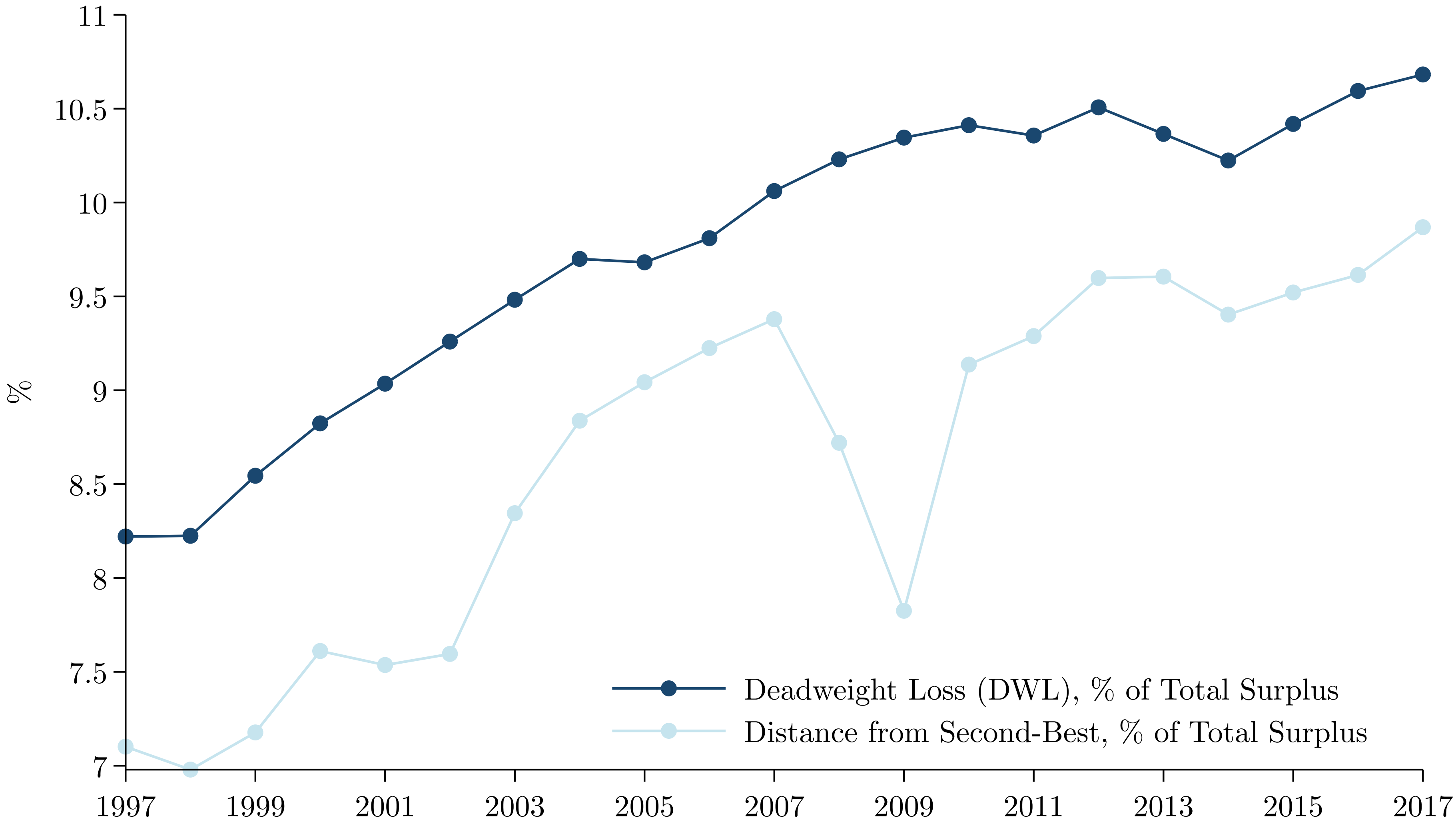
Outline of calibration:

- Δ : matches average markups estimated by De Loecker, Eeckhout and Unger (2020)
- α : matches micro-econometric estimates of cross-price demand elasticity from I.O. studies

Total Surplus and its Distribution



Pareto Efficiency



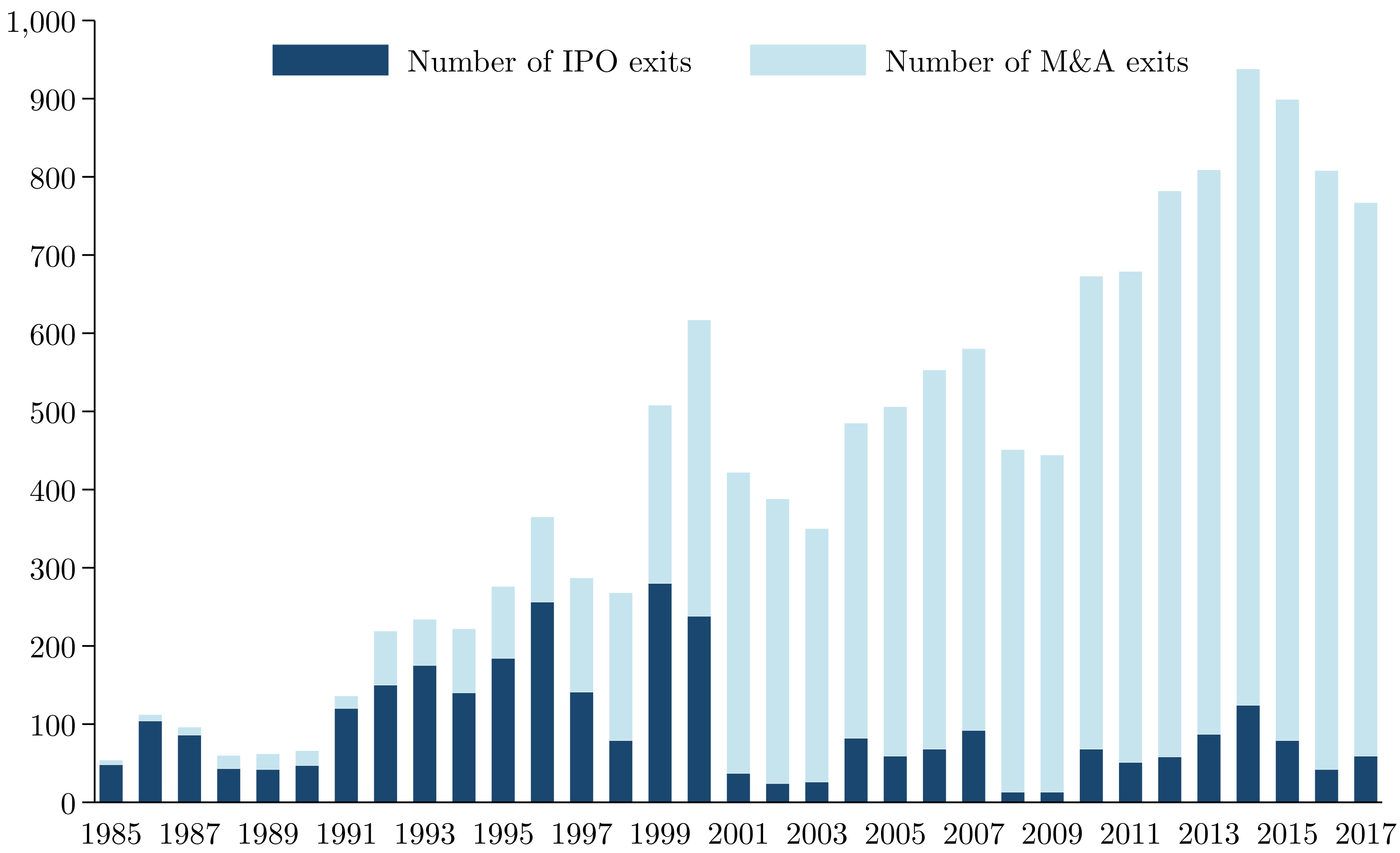
Robustness

- Inclusion/exclusion of foreign and private firms
- Fixed costs
- Intangible capital
- Multi-product firms (requires additional assumptions which I clarify in the paper).
- Common ownership (in a separate Paper not out yet)

What can account for these trends?

- **Fact**: the increase in concentration among Compustat firms is not driven by mergers between incumbents or increase in the rate of exit (bankruptcies and de-listings).
- Instead, it's driven by a well-documented secular decline in the rate of Initial Public Offers (IPOs) that began in the mid/late 90s (Gao, Ritter and Zhu, 2013).
- However, the problem is not a dearth of startups...

Venture capital exits by year and type

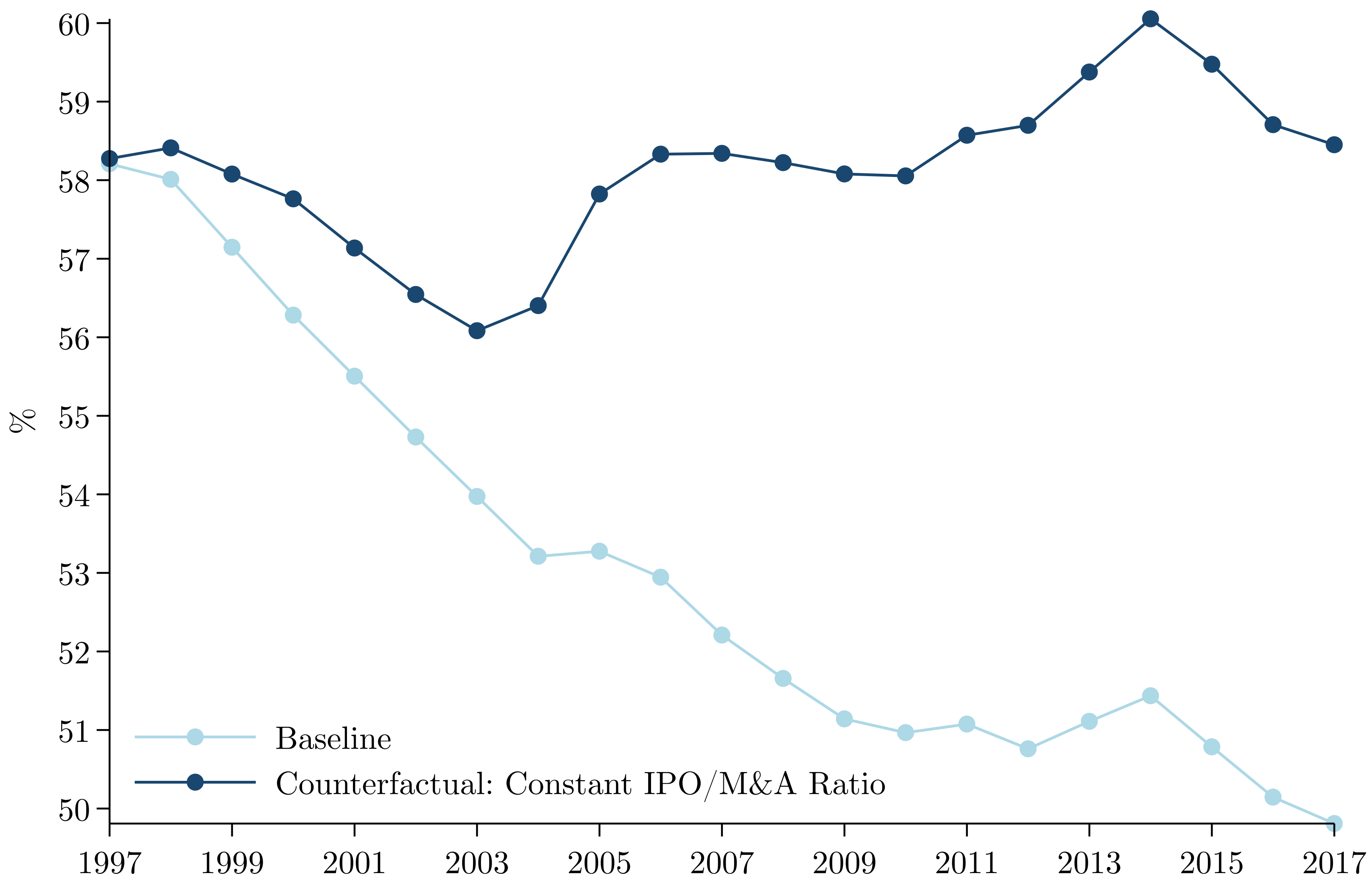


Startup Acquisitions

- **Counterfactual**: IPO rate constant. For each firm appearing after 1997, I spawn a number N of additional entrants with the same fundamentals, where N keeps the IPO rate constant after 1997.
- Caveats:

1. Acquisitions have increased also for non VC-backed startups, which are not counted (conservative)
2. On the other hand, we are not modelling synergies in acquisitions. Only "killer" acquisitions (most likely aggressive)
3. "Mechanical" exercise (does not say why IPOs declined)

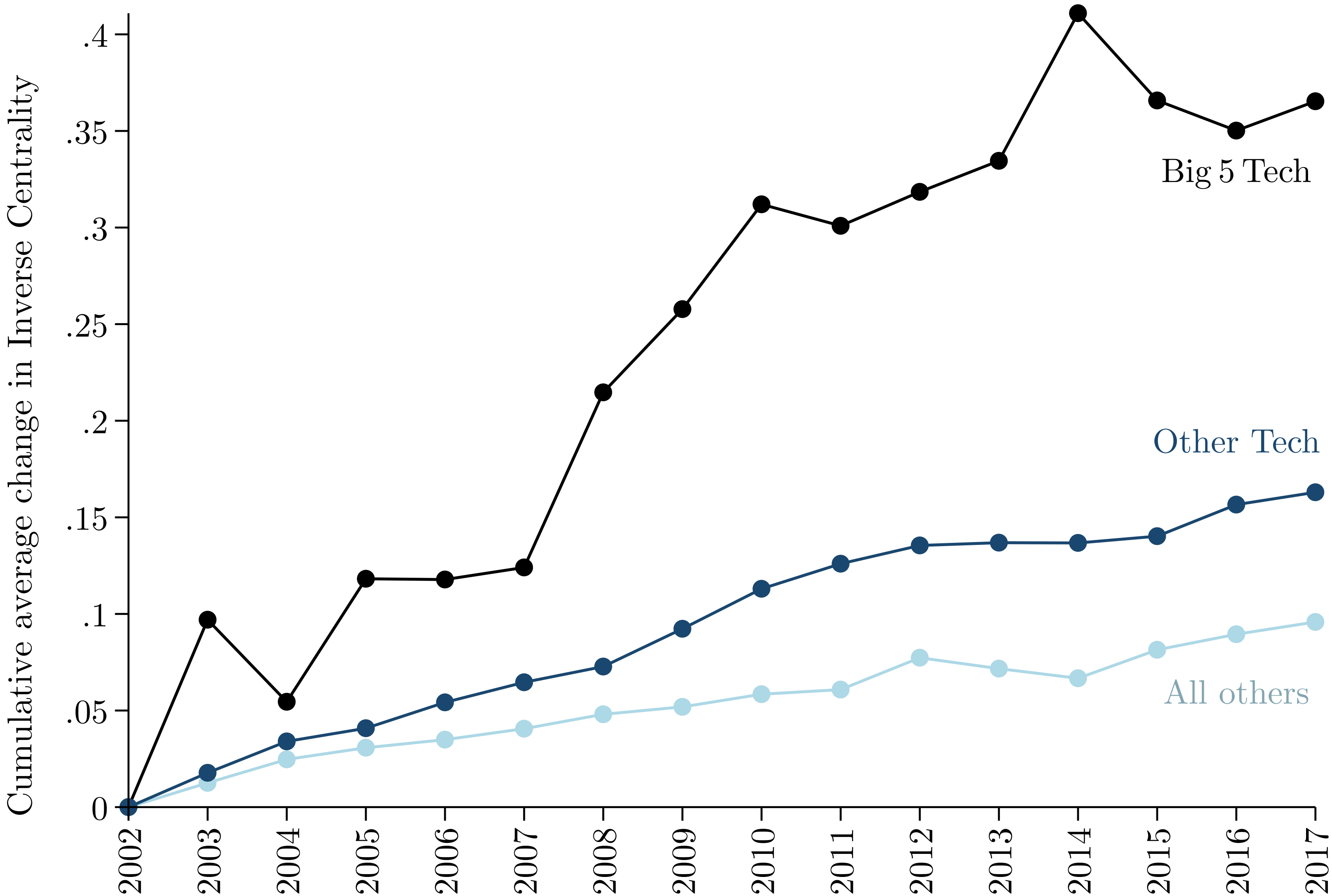
Consumer Surplus, as % of First best



These findings adds to a recent micro/IO literature on the implications of startup acquisitions for competition policy:

- Stealth Consolidation (Wollmann, 2019)
- Killer Acquisitions (Cunningham, Ederer & Ma, 2019)

Network Centrality as a Measure of Oligopoly



Taking Stock

- **A new GE model** of oligopoly with hedonic demand system with granular and atomistic firms.
- **10-K text data** to estimate the demand system for the universe of public firms.
- **Rising Oligopoly Power** measured as increasing deadweight loss and lower consumer surplus share.
- **Startup Acquisitions** are likely to have at least contributed to these trends.

(ending note: paper soon to be updated)

thank you