

# A Tale of Two Networks: Common Ownership and Product Market Rivalry<sup>\*</sup>

Florian Ederer<sup>†</sup>      Bruno Pellegrino<sup>‡</sup>

November 4, 2021

## Abstract

We study the welfare implications of the rise of common ownership and product market concentration in the United States from 1994 to 2018. We develop a general equilibrium model in which granular firms compete in a network game of oligopoly. Firms are connected through two large networks: the first reflects ownership overlap, the second product similarity. In our model, common ownership of competing firms induces unilateral incentives to soften product market competition. A key insight of our model is that the product market effects of common ownership depend crucially on the extent to which these two networks overlap. We estimate our model for the universe of public corporations in the U.S. using a combination of firm financials, investor holdings and text-based product similarity data. We perform counterfactual calculations to evaluate how the efficiency and the distributional impact of common ownership have evolved over time. According to our baseline estimates the welfare cost of common ownership, measured as deadweight loss-to-total surplus ratio, has increased nearly tenfold (from 0.3% to over 4%) between 1994 and 2018. Under alternative governance assumptions the deadweight loss ranges between 1.9% and 4.4% of total surplus. The rise of common ownership has also resulted in a significant reallocation of surplus from consumers to producers.

**JEL Codes:** D43, D61, E23, L13, L41, G34

**Keywords:** oligopoly, common ownership, concentration, networks

---

\*We are grateful to John Asker, José Azar, Matt Backus, Lorenzo Caliendo, Jan Eeckhout, Matthew Elliott, Paul Goldsmith-Pinkham, Jan De Loecker, Pete Kyle, Simon Mongey, Fiona Scott Morton, Jesse Shapiro, Mike Sinkinson, and Russ Wermers as well as seminar participants at UMD and Yale for helpful comments. Ian Veidenheimer provided outstanding research assistance.

<sup>†</sup>Yale University, School of Management and Cowles Foundation, [florian.ederer@yale.edu](mailto:florian.ederer@yale.edu)

<sup>‡</sup>University of Maryland, Robert H. Smith School of Business, [bpellegr@umd.edu](mailto:bpellegr@umd.edu)

# 1 Introduction

The U.S. economy has experienced two significant trends in concentration over the last three decades. First, across a broad range of U.S. industries revenue and employment concentration have increased (Grullon et al., 2019; Pellegrino, 2019). Second, ownership of U.S. corporate equity is increasingly concentrated in the hands of a few large institutional investors (Ben-David et al., 2020). This latter trend has been referred to as the rise of common ownership (Azar, 2012; Gilje, Gormley and Levit, 2018; Backus, Conlon and Sinkinson, 2021b). The increasing concentration of the two networks of ownership and product market rivalry as well as the resulting impact on welfare is the focus of this paper.

Under common ownership, large investors own shares in several firms that compete in the same markets. The tremendous increase in common ownership is of particular concern to policymakers (see, for example, Phillips (2018) and Vestager (2018)) because it lessens firms' economic incentives to aggressively compete against each other. If firms make strategic decisions with the intent of maximizing the profits accruing to their respective investors, common ownership can lead firms to (partially) internalize the effect of an increase in supply on their competitors' profits. This in turn induces them to produce lower quantities and charge higher markups, ultimately leading to larger deadweight losses. This concern is supported by a theoretical literature, starting with Rotemberg (1984), and empirical contributions, most notably Azar et al. (2018), that analyze oligopolistic behavior in the presence of common ownership.<sup>1</sup> In response, antitrust authorities around the world including the Department of Justice, the Federal Trade Commission, the European Commission, and the OECD, have acknowledged concerns about the anticompetitive effects of common ownership.<sup>2</sup>

In this paper, we analyze the rising concentration of the two networks of product similarity and ownership and evaluate the welfare cost and distributional effects of common ownership from a theoretical and empirical perspective. First, we develop a general equilibrium model in which granular firms compete in a network game of oligopoly. Firms are connected through two large networks: the first reflects ownership overlap, the second product similarity. Building on the rich literature on linear-quadratic network games (Ballester et al., 2006; Ushchev and Zenou, 2018) our model of oligopolistic competition is a generalization of the model of Pellegrino (2019) that allows for the presence of common ownership. Second, we estimate the model using data on firm financials, text-based product similarity (Hoberg and Phillips, 2016), and investor holdings (Backus et al., 2021b) covering the universe of U.S. publicly-listed corporations from 1994 to 2018. We perform

---

<sup>1</sup>Earlier empirical contributions include Matvos and Ostrovsky (2008) who document the effect of common ownership on shareholders' voting behavior in mergers & acquisitions and show that common owners are less likely to reject mergers.

<sup>2</sup>Solomon (2016) reported on an investigation based on Senate testimony by the head of the Antitrust Division, Federal Trade Commission (2018) featured a hearing on common ownership, and Vestager (2018) disclosed that the Commission is “looking carefully” at common ownership given indications of its increase and potential for anticompetitive effects. For other recent activity, see OECD (2017) and European Competition Commission (2017).

counterfactual calculations to evaluate how the efficiency and the distributional impact of common ownership have evolved over this period finding large negative consumer welfare effects.

Our model has two distinctive features. First, following the literature on hedonic demand (Lancaster, 1966; Rosen, 1974) the representative consumer has utility over product characteristics. Hence, the cross-price elasticity of demand between any two products depends on whether they possess similar attributes. This feature allows us to estimate a time-varying cross-price elasticity of demand that is specific to each firm pair, using the dataset of Hoberg and Phillips (2016). Second, firms act to maximize a weighted sum of profits earned by their investors, with each investor receiving a weight proportional to its ownership stake (Azar, 2012; López and Vives, 2019a; Backus et al., 2021b; Azar and Vives, 2021a). This setup is isomorphic to each firm maximizing a weighted sum of its own profits and its competitors' profits, with each company receiving a weight proportional to a well-defined measure of common ownership. A key model feature is that the anticompetitive effects of common ownership depend on the overlap between the two networks of product similarity and ownership.

Although the increase in common ownership is already well documented and a number of empirical papers have provided evidence for anticompetitive effects of common ownership on prices, quantities, markups, and profitability, no paper has estimated the welfare cost of common ownership. Taking as given that common ownership *does* affect competitive behavior, how large are the resulting product market welfare costs of the increase in common ownership and industry concentration in the U.S. economy over the past two decades?<sup>3</sup> Answering this question requires a model that is both tractable and flexible enough to accommodate the complex overlapping networks of product market competition and ownership that exist among public firms. The principal contribution of our paper is to propose such a model and to practically estimate it with data on product similarity and ownership networks.

The first step of our empirical analysis is to visualize the two networks in which firms are embedded: that of product similarity and that of common ownership. The network of product similarities displays a pronounced community structure: large groups of firms tend to cluster in certain areas of the network. In contrast, the network of common ownership has a hub-and-spoke structure with a large proportion of firms sharing significant overlap and the remainder of largely unconnected firms at the periphery. Second, across the distribution of firm pairs there is little correlation between product similarity and common ownership.

Next, we take the model to the data. Our estimation of the model reveals three broad patterns. First, the welfare costs of common ownership are significant, but not as large as the welfare costs of oligopoly. We estimate that in 2018, the most recent year of our sample, the deadweight loss of

---

<sup>3</sup>Our model and empirical analysis abstract away any labor market effects of common ownership which may result from enhanced employer power as in the theoretical analysis of Azar and Vives (2021a). Furthermore, we do not consider coordinated effects of common ownership which may result from explicit or tacit collusion between firms or owners as documented by Shekita (2021). Thus, our analysis focuses exclusively on the welfare costs of *unilateral product market* effects of common ownership.

oligopoly amounts to about 11.5% of total surplus while the level of common ownership leads to an additional deadweight loss of 4% of total surplus. Second, the welfare losses of common ownership fall entirely on consumers. We estimate that in 2018 common ownership raises aggregate profits by \$378 billion (from \$5.261 trillion to \$5.639 trillion), but lowers consumer surplus by \$799 billion (from \$4.113 trillion to \$3.314 trillion). Third, the negative effects of common ownership on total welfare and consumer surplus have grown considerably over the last two decades. Whereas common ownership reduced total surplus by a mere 0.3% in 1994 this deadweight loss increased more than tenfold to 4% in 2018. Over the same time period, common ownership raised corporate profits by 1% in 1994 and 6.6% in 2018, but lowered consumer surplus by less than 2% in 1994 but almost 20% in 2018.

We further explore how alternative assumptions about corporate governance modify these results. Indeed, there are good reasons to believe that larger investors exert influence that exceeds the size of their stake. We therefore build an alternative version of the model with “superproportional” influence. Under these alternative assumptions, common ownership has essentially identical effects on deadweight loss, corporate profits, and consumer surplus. In contrast, when we assume that only blockholders (i.e., shareholders holding 5% or more of a company’s stock) can exert influence or that large diversified owners have limited attention we find that common ownership only has a relatively small welfare impact until 2013. However, even under blockholder influence, common ownership leads to a deadweight loss of 2.5% of total surplus, raises firm profits by almost 5% and lowers consumer surplus by almost 13% of total surplus in 2018. These results continue to hold when we incorporate limits to investor attention.

The closest theoretical paper to our work is the macroeconomic framework of [Azar and Vives \(2021a\)](#) in which symmetric common ownership across identical oligopolistic firms leads to additional market power with respect to both product market competition and labor hiring. In contrast to their paper, our model assumes competitive labor markets to focus exclusively on the product market effects of common ownership, but allows for arbitrary size differences between firms. Furthermore, we develop a model with a flexible demand system that can be taken to the data to identify structural parameters. This allows us not only to make qualitative theoretical predictions, but also to produce quantitative time-varying dollar estimates of the (product market) welfare consequences of common ownership.

Although our paper analyzes the welfare effects of product market power, a question that is central to the field of industrial organization, it is also connected to two growing subfields of macroeconomics that rely on microeconomic data. First, our paper is related to the literature on networks ([Acemoglu et al., 2012; Carvalho, 2014; Acemoglu et al., 2017; Carvalho and Tahbaz-Salehi, 2019; Baqaee and Farhi, 2020b; Carvalho et al., 2021](#)). Whereas those papers focus on input-output networks we study networks of ownership and product market rivalry. As a result, our work is also related to [Bloom et al. \(2013\)](#) who analyze the impact of product market rivalry networks among publicly-listed firms on innovation. Second, our work is related to the growing

body of academic work on markups and industry concentration (De Loecker et al., 2020; Autor et al., 2020; Edmond et al., 2018; Covarrubias et al., 2020; Syverson, 2019).<sup>4</sup> By incorporating hedonic demand and data on product market similarity and ownership we are able to create a rich, high-dimensional representation of the competitive environment in which firms differ not only by their productivity, but also by their products' characteristics and their ownership connections.

Finally, our paper is related to empirical studies providing market-, industry-level, and economy-wide evidence on common ownership which are comprehensively surveyed by Schmalz (2018) and Backus et al. (2019).<sup>5</sup> In contrast to much of the literature, we do not analyze whether or not common ownership affects the competitive conduct of firms, but instead estimate the economy-wide welfare and distributional effects of increased product market power due to common ownership for a range of different corporate governance assumptions.

The rest of the paper is organized as follows. Section 2 develops our theoretical model. Section 3 describes the data and Section 4 reports the empirical results for the baseline model of corporate governance. Section 5 provides additional empirical results under alternative corporate governance and cost structure assumptions. Section 6 concludes.

## 2 Theoretical Model

We develop a general equilibrium model in which granular firms compete in a network game of Cournot oligopoly. Firms are connected through two large networks: the first reflects ownership overlap, the second product similarity. For expositional purposes, we present the basic model that only considers proportional proportional ownership influence. After characterizing the equilibrium of this model economy and outlining a series of counterfactuals of interest, we extend the model to consider alternative governance assumptions.

### 2.1 Generalized Hedonic-Linear (GHL) Demand System

There is a representative agent who is a consumer, worker, and owner. This representative agent consumes all the goods produced in the economy, supplies labor as a production input, and receives income from owning shares of all the firms in the economy.

There are  $n$  firms, indexed by  $i \in \{1, 2, \dots, n\}$  that produce differentiated products. Consumers have hedonic demand (Lancaster, 1966; Rosen, 1974) and value each product as a bundle of characteristics. The number of characteristics is  $m + n$ .

---

<sup>4</sup>To our knowledge the earliest empirical study estimating the deadweight loss resulting from firms' product market power in the U.S. economy is Harberger (1954). Other early contributions to this literature include Kamerschen (1966), Bergson (1973), and Cowling and Mueller (1978).

<sup>5</sup>Notable theoretical contributions include early work by Rubinstein and Yaari (1983) and Rotemberg (1984), and recent papers by López and Vives (2019b) and Backus et al. (2021b). Empirical work on this topic includes papers by Boller and Scott Morton (2020), Newham et al. (2019), Xie and Gerakos (2020), Antón et al. (2020), Li et al. (2020), Eldar et al. (2020), Shekita (2021), Backus et al. (2021a) and Saidi and Streitz (2021).

Each product has two types of characteristics:  $m$  common characteristics indexed by  $j \in \{1, 2, \dots, m\}$  and  $n$  idiosyncratic characteristics. Because these characteristics are product-specific and not present in other products they have the same index  $i$  as the corresponding product. The scalar  $a_{ji}$  is the number of units of common characteristic  $j$  provided by product  $i$ . Each product is described by an  $m$ -dimensional column vector  $\mathbf{a}_i$ , which we assume, without loss of generality, to be of unit length:

$$\mathbf{a}_i = \begin{bmatrix} a_{1i} & a_{2i} & \dots & a_{mi} \end{bmatrix}' \quad (2.1)$$

$$\text{such that } \sum_{j=1}^m a_{ji}^2 = 1 \quad \forall i \in \{1, 2, \dots, n\} \quad (2.2)$$

The vector  $\mathbf{a}_i$  provides firm  $i$ 's coordinates in the space of common characteristics. We stack all the coordinate vectors  $\mathbf{a}_i$  inside the  $m \times n$  matrix  $\mathbf{A}$ :

$$\mathbf{A} = \begin{bmatrix} \mathbf{a}_1 & \mathbf{a}_2 & \dots & \mathbf{a}_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} \quad (2.3)$$

Let  $q_i$  be the number of units produced by firm  $i$  and consumed by the representative agent. The  $n$ -dimensional vector  $\mathbf{q}$  contains the quantities of all the  $n$  firms in the economy and is given by

$$\mathbf{q} = \begin{bmatrix} q_1 & q_2 & \dots & q_n \end{bmatrix}' \quad (2.4)$$

An *allocation* is a vector  $\mathbf{q}$  that specifies, for every firm, the number of units produced.

The representative agent linearly combines the characteristics of different products and the consumer's preferences are defined in terms of these characteristics. Denote the total units of common characteristic  $j$  by  $x_j$

$$x_j = \sum_i a_{ji} q_i \quad (2.5)$$

The matrix  $\mathbf{A}$  projects the vector of units purchased  $\mathbf{q}$  on the space of common characteristics:

$$\mathbf{x} = \mathbf{A}\mathbf{q} \quad (2.6)$$

Each unit of good  $i$  provides one unit of its corresponding idiosyncratic characteristic. This allows us to write  $q_i$  in place of the units of idiosyncratic characteristic  $i$ . The representative agent has a utility function which is quadratic in common ( $\mathbf{x}$ ) and idiosyncratic ( $\mathbf{q}$ ) characteristics and

which also incorporates a linear disutility for the total number of hours worked  $H$ . It is given by

$$U(\mathbf{x}, \mathbf{q}, H) \stackrel{\text{def}}{=} \alpha \cdot \sum_{j=1}^m \left( b_j^x x_j - \frac{1}{2} x_j^2 \right) + (1 - \alpha) \sum_{i=1}^n \left( b_i^q q_i - \frac{1}{2} q_i^2 \right) - H \quad (2.7)$$

where  $b_j^x$  and  $b_i^q$  are characteristic-specific preference shifters.  $\alpha \in [0, 1]$  is the utility weight of common characteristics, and it governs the degree of *horizontal differentiation* among products (Epple, 1987).

Making leisure the outside good allows us to close the general equilibrium model. We denote by  $h_i$  the labor input acquired by every firm  $i$ . The labor market clearing condition is

$$H = \sum_i h_i. \quad (2.8)$$

Labor is the numéraire of this economy such that the price of one unit of labor is 1. Therefore, the total variable cost incurred by firm  $i$  is equal to the labor input  $h_i$ . Firm  $i$  produces output  $q_i$  using a quasi-Cobb Douglas production function

$$q_i = k_i^\theta \cdot \ell(h_i) \quad (2.9)$$

where  $k_i$  is the (fixed) capital input. The function  $\ell(\cdot)$  is such that firm  $i$ 's production technology is given by a quadratic total variable cost function

$$h_i = c_i q_i + \frac{\delta_i}{2} q_i^2 \quad (2.10)$$

where  $c_i$  and  $\delta_i$  depend on  $k_i$ . The marginal cost (MC) and the average variable cost (AVC) are given by

$$MC_i = c_i + \delta_i q_i; \quad AVC_i = c_i + \frac{\delta_i}{2} q_i. \quad (2.11)$$

In our empirical robustness checks in Section 5, we will include fixed costs  $f_i$  such that firm  $i$ 's total cost function is equal

$$TC_i = f_i + c_i q_i + \frac{\delta_i}{2} q_i^2 \quad (2.12)$$

The representative agent buys the goods bundle  $\mathbf{q}$  taking prices  $\mathbf{p}$  as given and receives the aggregate profits from holding shares of all the companies in the economy. We specify the exact ownership arrangements in Section 2.4. The agent's budget constraint is thus given by

$$H + \Pi = \sum_{i=1}^n p_i q_i. \quad (2.13)$$

## 2.2 Consumption Choices, Labor Supply, and Product Demand

Define

$$\mathbf{b} \stackrel{\text{def}}{=} \alpha \mathbf{A}' \mathbf{b}^x + (1 - \alpha) \mathbf{b}^q \quad (2.14)$$

We obtain the Lagrangian for the representative agent by plugging equation (2.6) and (2.14) into equation (2.7):

$$\mathcal{L}(\mathbf{q}, H) = \mathbf{q}' \mathbf{b} - \frac{1}{2} \mathbf{q}' [\mathbf{I} + \alpha (\mathbf{A}' \mathbf{A} - \mathbf{I})] \mathbf{q} - H - \lambda (\mathbf{q}' \mathbf{p} - H - \Pi) \quad (2.15)$$

Labor is the numéraire and hence the Lagrange multiplier is  $\lambda = 1$ . As a result, the consumer chooses a demand function  $\mathbf{q}(\mathbf{p})$  to maximize the consumer surplus function:

$$CS(\mathbf{q}) = \mathbf{q}' (\mathbf{b} - \mathbf{p}) - \frac{1}{2} \mathbf{q}' [\mathbf{I} + \alpha (\mathbf{A}' \mathbf{A} - \mathbf{I})] \mathbf{q} \quad (2.16)$$

$\mathbf{a}_i' \mathbf{a}_j$  is the *cosine similarity* between  $i$  and  $j$ . It measures the cosine of the angle between vectors  $\mathbf{a}_i$  and  $\mathbf{a}_j$  in the space of common characteristics  $\mathbb{R}^m$  and ranges from 0 to 1. By definition the matrix  $\mathbf{A}' \mathbf{A}$  contains the *cosine similarities* between all firm pairs. When two products overlap more in the characteristics space, they have a higher cosine similarity and this is reflected in the product substitution patterns. If  $\mathbf{a}_i' \mathbf{a}_j > \mathbf{a}_i' \mathbf{a}_{j'}$ , an increase in the supply of product  $i$  leads to a larger decline in the marginal utility of product  $j$  than it does on the marginal utility of product  $j'$ .

Define the firm similarity matrix

$$\boldsymbol{\Sigma} \stackrel{\text{def}}{=} \alpha (\mathbf{A}' \mathbf{A} - \mathbf{I}). \quad (2.17)$$

Thus, the demand and inverse demand functions are given by

$$\text{Aggregate demand : } \mathbf{q} = (\mathbf{I} + \boldsymbol{\Sigma})^{-1} (\mathbf{b} - \mathbf{p}) \quad (2.18)$$

$$\text{Inverse demand : } \mathbf{p} = \mathbf{b} - (\mathbf{I} + \boldsymbol{\Sigma}) \mathbf{q} \quad (2.19)$$

The quantity sold by each firm affects the price of the output sold by every other firm in the economy unless the matrix  $\boldsymbol{\Sigma}$  is null. The derivative  $\partial p_i / \partial q_j$  is proportional to  $\mathbf{a}_i' \mathbf{a}_j$ , the product similarity between  $i$  and  $j$ . The closer these two firms are in the product characteristics space, the larger is this derivative in absolute value. Because  $\mathbf{A}' \mathbf{A}$  is symmetric, we have  $\partial q_i / \partial p_j = \partial q_j / \partial p_i$  by construction.

The economic profits  $\pi_i$  of firm  $i$  are therefore given by

$$\begin{aligned}\pi_i(\mathbf{q}) &\stackrel{\text{def}}{=} p_i(\mathbf{q}) \cdot q_i - h_i \\ &= q_i(b_i - c_i) - \left(1 + \frac{\delta_i}{2}\right) q_i^2 - \sum_{j \neq i} \sigma_{ij} q_i q_j.\end{aligned}$$

## 2.3 Advantages of GHL

### 2.3.1 Complementarities

Our network Cournot model allows for complementarities despite the fact that  $\Sigma$  is non-negative by construction and hence the marginal utility from one unit of product  $j$  is always non-increasing in  $q_i$ :

$$\frac{\partial^2 \text{CS}}{\partial q_i \partial q_j} = -\sigma_{ij} \leq 0 \quad \forall i \neq j \quad (2.20)$$

However, this does not mean that all products are by construction substitutes and that no pair of products are complements. Recall the definition of complements and substitutes based on cross-price effects:

$$\text{Complements if } \frac{\partial q_i}{\partial p_j} < 0 \quad \text{Substitutes if } \frac{\partial q_i}{\partial p_j} > 0 \quad (2.21)$$

The important insight is that the cross-price elasticity of demand depends on the inverted matrix  $(\mathbf{I} + \Sigma)^{-1}$ , not on  $\Sigma$  itself. If, as in our case,  $\Sigma$  is not symmetric, the off-diagonal elements of  $-(\mathbf{I} + \Sigma)^{-1}$  will generally include positive as well as negative elements. This implies that some product  $ik$  pairs are complements in the sense defined above and thus the quantity choices  $q_i$  and  $q_k$  can be strategic complements. Intuitively, this perhaps surprising complementarity arises from a dynamic that is similar to “the enemy of my enemy is my friend.” An increase in quantity  $q_i$  leads to a reduction in residual demand for firm  $j$  and thus a decrease in quantity  $q_j$ , but this in turn implies an increase in residual demand firm  $k$  and thus an increase in quantity  $q_k$ .

This complementarity matches realistic features of economy-wide substitution patterns. For example, our computed vector of cross-price derivatives for General Motors in 2018 includes several negative elements (i.e., complements), including energy and consumer finance companies: higher oil prices, loan rates, or insurance premia adversely affect the residual demand for cars.

### 2.3.2 Demand Estimates

GHL differs from the perhaps more standard CES demand in that it produces linear (as opposed to isoelastic) residual demands. Hence, demand elasticity decreases with firm size and bigger firms charge larger markups. Because we are interested in the quantitative welfare implications of oligopoly and common ownership and these crucially rely on our demand estimates, it is particularly important that the demand system of our model provides a good approximation of actual demand.

FIGURE 1: DEMAND SYSTEM COMPARISON

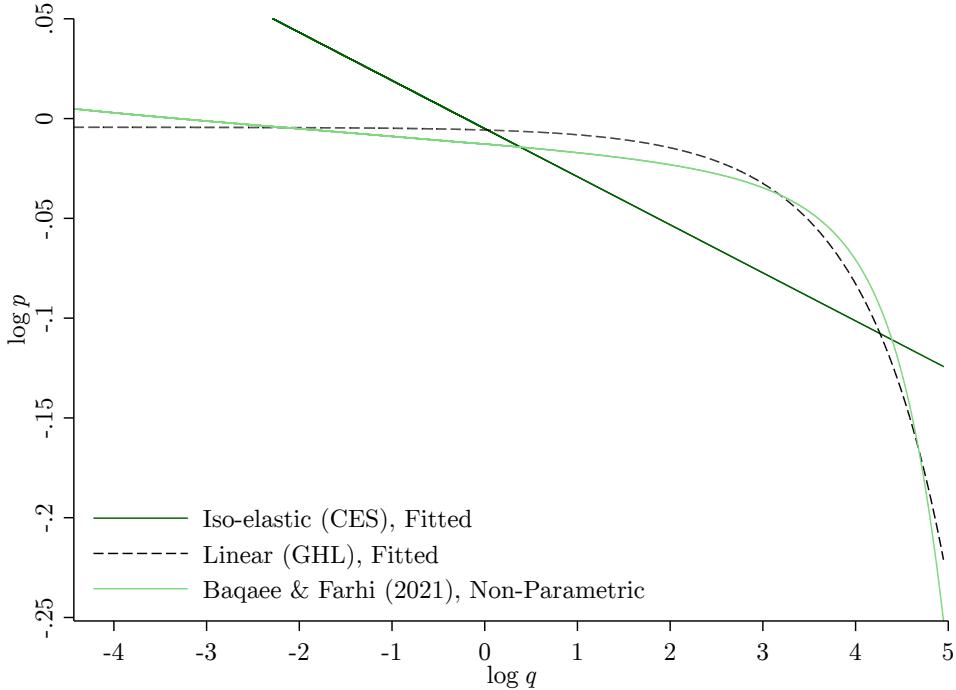


FIGURE NOTES: The figure shows a log-log plot of the demand curve estimated non-parametrically by [Baqae and Farhi \(2020a\)](#) (solid light green line), against a linear (GHL) fit (dotted black line) and against an isoelastic (CES) fit (solid dark green line). Note that an isoelastic curve becomes a straight line in a log-log plot. [Baqae and Farhi \(2020a\)](#)'s model demand curve is obtained from price-cost passthrough estimates by [Amiti et al. \(2019\)](#).

Thus, an important issue to evaluate is how well GHL matches empirical demand curves estimates when compared to CES.

In Figure 1 we plot three different demand curves based on CES demand, GHL demand, and non-parametric demand estimates by [Baqae and Farhi \(2020a\)](#) respectively.<sup>6</sup> Whereas the GHL demand curve closely matches the non-parametric estimates of [Baqae and Farhi \(2020a\)](#), the isoelastic CES demand curve does not seem to match the data very well.

## 2.4 Ownership

There are  $Z$  investment funds which are owned by the representative agent and indexed by  $z$ .  $V_z$ , the value of fund  $z$ , is the sum of the profits that they are entitled to based on their ownership

<sup>6</sup>[Baqae and Farhi \(2020a\)](#) fit a residual demand curve non-parametrically using price-cost passthrough estimates by [Amiti et al. \(2019\)](#) based on Belgian manufacturing enterprise micro data.

share in each company  $i$ :

$$V_z \stackrel{\text{def}}{=} \sum_{i=1}^n s_{iz} \pi_j \quad \sum_{z=1}^Z s_{iz} = 1 \quad (2.22)$$

where  $s_{jz}$  is the percentage of shares of company  $j$  owned by investor  $z$ . Following Rotemberg (1984), we assume that the manager of firm  $i$  maximizes  $\phi_i$ , an average of firm  $i$ 's investors' value functions, weighted by the investors' ownership shares in all firms in the economy:

$$\phi_i \stackrel{\text{def}}{=} \sum_{z=1}^Z s_{iz} V_z = \sum_{z=1}^Z s_{iz} \sum_{j=1}^n s_{jz} \pi_j = \sum_{j=1}^n \pi_j \sum_{z=1}^Z s_{iz} s_{jz} \quad (2.23)$$

We assume that firms engage in Cournot competition and that the profit functions are concave. Hence, to maximize  $V_i$ , firm  $i$ 's management sets the following derivative with respect to  $q_i$  equal to zero:

$$\begin{aligned} \frac{\partial \phi_i}{\partial q_i} &= \sum_{j=1}^n \mathbf{s}'_i \mathbf{s}_j \cdot \frac{\partial \pi_j}{\partial q_i} \\ &= \mathbf{s}'_i \mathbf{s}_i \left[ b_i - c_i - (2 + \delta_i) q_i - \alpha \sum_{j \neq i} \mathbf{a}'_i \mathbf{a}_j q_i \right] - \alpha \sum_{j \neq i} \mathbf{s}'_i \mathbf{s}_j \cdot \mathbf{a}'_i \mathbf{a}_j \cdot q_i \end{aligned}$$

where

$$\mathbf{s}_i \stackrel{\text{def}}{=} \begin{bmatrix} s_{i1} & s_{i2} & \dots & s_{iZ} \end{bmatrix}' \quad (2.24)$$

The common ownership weights  $\kappa_{ij}$  are defined as

$$\kappa_{ij} \stackrel{\text{def}}{=} \frac{\mathbf{s}'_i \mathbf{s}_j}{\mathbf{s}'_i \mathbf{s}_i} \quad (2.25)$$

which allows us to rewrite firm  $i$ 's objective function in the following way

$$\phi_i \propto \pi_i + \sum_{j \neq i} \kappa_{ij} \pi_j. \quad (2.26)$$

Our notation directly follows Backus et al. (2021b) and Antón et al. (2020).<sup>7</sup> We interpret  $\kappa_{ij}$  as the weight—due to common ownership—that each firm (or each manager)  $i$ 's objective function assigns to the profits of other firms relative to its own profits and corresponds to what Edgeworth (1881) termed the “coefficient of effective sympathy among firms.”

At this point it is worth discussing our assumption that the manager of firm  $i$  maximizes  $\phi_i$ . First, there is a long tradition in economics of weighting shareholder interests in the objective function of the firm, including Drèze (1974), Grossman and Hart (1979), and Rotemberg (1984).

---

<sup>7</sup>López and Vives (2019a) and Azar and Vives (2021a) use the same formulation but denote  $\kappa_{ij}$  by  $\lambda_{ij}$ .

Second, more recently, the common ownership literature has used the same objective function for firms as in equation (2.26) with [Azar \(2020\)](#) providing microeconomic foundations for the firm manager's maximization choice.

However, this assumption that firms (or managers) maximize the weighted portfolio profits of their investors differs from [Azar and Vives \(2021a\)](#). They instead assume a two-class economy with worker-consumers and owner-consumers, in which firms maximize the weighted *utilities* of their owner-consumers.<sup>8</sup> In their model, firms are assumed to take into account that their strategic decisions affect both their investors' portfolio profits *and* their investors' consumption choices through the firm quantities' influence on the aggregate price index. For example, under the latter part of this assumption airlines internalize that some of its investors are also air travelers and setting higher quantities lowers the relative price of air travel in the consumption bundle of these owner-consumers and directly benefits them.

In contrast, in our model firms only internalize any effects on investors' portfolio profits, but ignore the impact of their quantity choices on the consumption bundles of their investors. First, we believe that this assumption is a better description of what firms actually do. In an economy with many diverse consumer-owners who consume a changing baskets of goods it would be exceedingly difficult for those at the helm of firms to keep track of the impact of strategic decisions on investor utilities. Second, it is likely that the consumption bundles of firm managers and other consumers in the economy differ significantly. For example, [Bertrand and Kamenica \(2018\)](#) document that the divergence in consumer behavior is fairly constant over time and larger than for other cultural distances such as media diet, time use, or social attitudes. Assume, therefore, that there are two types of agents: managers and consumer-workers. The strategic decisions of each firm  $i$  are in the hands of a manager (also indexed by  $i$ ). We assume that the manager's compensation is equal to

$$\omega_i = \varepsilon \sum_{z=1}^Z s_{iz} V_z \quad (2.27)$$

with  $\varepsilon$  arbitrarily small. Managers have increasing utility over and spend all of their income on a "luxury" good (e.g., yachts or private jets)<sup>9</sup> indexed by 0, which is produced competitively with a linear technology using only labor. Let  $q_{i0}$  denote the quantity of luxury good purchased by the manager of firm  $i$ ,  $p_0$  the price, and  $h_0$  the total work. We then have the following market clearing

---

<sup>8</sup>Oligopoly deadweight losses, markups and misallocation arise because of a conflict between classes. At a fundamental level, this is because the agents that are in charge of production consume a different set of goods from the rest, and therefore do not internalize how their choices affect the real income of other agents. In [Azar and Vives \(2021a\)](#) the two-class divide between worker-consumers and owner-consumers is the source of the anticompetitive labor market effect of common ownership.

<sup>9</sup>This setup is reminiscent of [Veblen \(1899\)](#) as some agents engage in conspicuous consumption that is distinct from the basket of goods consumed by the representative worker-consumer.

condition for the production of good 0

$$\sum_{i=1}^I q_{i0} = h_0 \quad (2.28)$$

and the price  $p_0$  is one by construction. The assumption of  $\varepsilon$  being arbitrarily small implies that the labor used to produce good 0 is a negligible share of total labor in the economy.

In line with much of the common ownership literature, we focus on unilateral effects (Ivaldi et al., 2003b) and do not consider coordinated effects (Ivaldi et al., 2003a) of common ownership (e.g., increased incentives and ability to collude). That is to say, we do not assume that firms with overlapping ownership can successfully coordinate their behaviour in an anticompetitive way, for example, by lowering quantities.

By taking the profit vector as a payoff function and the vector of quantities  $\mathbf{q}$  as a strategy profile we can implicitly define a *linear-quadratic network game* (Ballester et al., 2006). Loosely speaking, this is because the combination of the matrices  $\Sigma$  (the network of product market rivalry relationships that exists among the firms which is based on the substitutability of their products) and  $\mathbf{K}$  (the network of ownership relationships based on the firms' investor shares) is essentially the adjacency matrix of a weighted network. Linear-quadratic network games like ours belong to a larger class of games known as "potential games" (Monderer and Shapley, 1996) because they can be described by a scalar function which is called the game's potential.

We can now write the vector of the firms' first order conditions as

$$\mathbf{0} = (\mathbf{b} - \mathbf{c}) - (2\mathbf{I} + \Delta + \Sigma + \mathbf{K} \circ \Sigma) \mathbf{q} \quad (2.29)$$

$$\text{where } \Delta \stackrel{\text{def}}{=} \begin{bmatrix} \delta_1 & 0 & \cdots & 0 \\ 0 & \delta_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \delta_n \end{bmatrix} \quad (2.30)$$

The diagonal matrix  $\Delta$ , which contains the slopes of the marginal cost functions, captures economies of scale.  $\Sigma$  and  $\mathbf{K}$  are the adjacency matrices of the networks of product rivalry and common ownership. Specifically,  $\mathbf{K}$  is the  $n \times n$  common ownership matrix of  $\kappa_{ij}$  for all  $n$  firms in the economy and  $\circ$  denotes the Hadamard (element-by-element) product.  $\mathbf{b}$  and  $\mathbf{c}$  are the demand and supply function intercepts and  $b_i$  can be interpreted as a measure of firm product quality or vertical product differentiation.

This vector of first order conditions yields the following equilibrium quantity vector  $\mathbf{q}^\Xi$  under *Cournot Common Ownership* (CCO) which determines the size of each firm in equilibrium.

**Definition 1.** The *Cournot Common Ownership* allocation  $\mathbf{q}^\Xi$  is defined as:

$$\mathbf{q}^\Xi \stackrel{\text{def}}{=} \arg \max_{\mathbf{q}} \Xi(\mathbf{q}) = (2\mathbf{I} + \Delta + \Sigma + \mathbf{K} \circ \Sigma)^{-1} (\mathbf{b} - \mathbf{c}). \quad (2.31)$$

## 2.5 Market Structure and Ownership Counterfactuals

We use our theoretical model to study how welfare statistics such as total surplus respond to changes in market structure. Our baseline assumption is that firms compete as in an economy-wide Cournot oligopoly in which the manager of each firm  $i$  maximizes the objective function  $\phi_i$  which results in the Cournot Common Ownership allocation in equation (2.31). We now consider counterfactuals in which the same firms make production decisions with alternative objective functions. For example, rather than maximizing portfolio profits  $\phi_i$  firms maximize just their own profits  $\pi_i$  as under standard Cournot competition. Each of these counterfactuals, summarized in the set of equations in (2.32) and inversely ranked by their degree of competitiveness, is the maximizer of a specific scalar quadratic function, which we call *potential* following the nomenclature of [Monderer and Shapley \(1996\)](#).<sup>10</sup> For example, the potential function  $\Xi(\mathbf{q})$  can be thought of, intuitively, as the objective function of the *pseudo-planner* problem that is solved by the Nash equilibrium allocation under common ownership whereas the potential function  $\Psi(\mathbf{q})$  is the objective function of the pseudo-planner problem for the Nash equilibrium allocation without common ownership.

$$\begin{aligned}
 \text{Monopoly Potential : } \Pi(\mathbf{q}) &= \mathbf{q}' (\mathbf{b} - \mathbf{c}) - \mathbf{q}' \left( \mathbf{I} + \frac{1}{2} \mathbf{\Delta} + \mathbf{\Sigma} \right) \mathbf{q} \\
 \text{CCO Potential : } \Xi(\mathbf{q}) &= \mathbf{q}' (\mathbf{b} - \mathbf{c}) - \mathbf{q}' \left( \mathbf{I} + \frac{1}{2} \mathbf{\Delta} + \frac{1}{2} \mathbf{\Sigma} + \frac{1}{2} \mathbf{K} \circ \mathbf{\Sigma} \right) \mathbf{q} \\
 \text{Cournot Potential : } \Psi(\mathbf{q}) &= \mathbf{q}' (\mathbf{b} - \mathbf{c}) - \mathbf{q}' \left( \mathbf{I} + \frac{1}{2} \mathbf{\Delta} + \frac{1}{2} \mathbf{\Sigma} \right) \mathbf{q} \\
 \text{Total Surplus : } W(\mathbf{q}) &= \mathbf{q}' (\mathbf{b} - \mathbf{c}) - \frac{1}{2} \cdot \mathbf{q}' (\mathbf{I} + \mathbf{\Delta} + \mathbf{\Sigma}) \mathbf{q}
 \end{aligned} \tag{2.32}$$

We first consider *Cournot* competition which assumes away any common ownership effects by assuming that investors do not hold diversified portfolios.

**Definition 2.** The *Cournot* allocation  $\mathbf{q}^\Psi$  is defined as that in which all profit weights  $\kappa_{ij}$  in  $\mathbf{K}$  are equal to 0 for  $i \neq j$  and equal to 1 for  $i = j$ :

$$\mathbf{q}^\Psi \stackrel{\text{def}}{=} \arg \max_{\mathbf{q}} \Psi(\mathbf{q}) = (2\mathbf{I} + \mathbf{\Delta} + \mathbf{\Sigma})^{-1} (\mathbf{b} - \mathbf{c}) \tag{2.33}$$

Next we consider *Perfect Competition* in which firms act as atomistic producers and price all units at marginal cost.

**Definition 3.** The *Perfect Competition* allocation  $\mathbf{q}^W$  is defined as the maximizer of the aggregate

---

<sup>10</sup>The closed-form expressions for the output vector  $\mathbf{q}$  which we provide below assume an interior solution. For our empirical analysis, we also compute a numerical solution that is subject to a non-negativity constraint on  $\mathbf{q}$  and we verify that it is approximately equal to the unconstrained solution (error < 0.1% for the total surplus function in perfect competition). The non-negativity constraint binds for very few firms.

total surplus function  $W(\mathbf{q})$ :

$$\mathbf{q}^W \stackrel{\text{def}}{=} \arg \max_{\mathbf{q}} W(\mathbf{q}) = (\mathbf{I} + \boldsymbol{\Delta} + \boldsymbol{\Sigma})^{-1} (\mathbf{b} - \mathbf{c}) \quad (2.34)$$

The least competitive allocation is *Monopoly*. It represents a situation in which one agent who does not internalize consumer surplus, has control over all the firms in the economy and maximizes the aggregate profits of all firms.

**Definition 4.** The *Monopoly* allocation  $\mathbf{q}^\Pi$  is defined as the maximizer of the aggregate profit function  $\Pi(\mathbf{q})$ :

$$\mathbf{q}^\Pi \stackrel{\text{def}}{=} \arg \max_{\mathbf{q}} \Pi(\mathbf{q}) = (2\mathbf{I} + \boldsymbol{\Delta} + 2\boldsymbol{\Sigma})^{-1} (\mathbf{b} - \mathbf{c}) \quad (2.35)$$

This allocation can be alternatively conceptualized as an economy without any antitrust policy restricting ownership allocations, in which firms have unlimited ability to coordinate their supply choices. This allocation is the limit of a Cournot equilibrium with common ownership when all of the profit weights tend to one (i.e.,  $\kappa_{ij} \rightarrow 1$ ).

### 3 Data

#### 3.1 Text-Based Product Similarity

The key data input required to apply our model to the data is the matrix of product similarities  $\mathbf{A}'\mathbf{A}$ . Our empirical counterpart to this object comes from [Hoberg and Phillips \(2016\)](#), henceforth HP), who compute product cosine similarities for firms in Compustat by analyzing the text of their 10-K forms. The form contains a *product description* section, which is the target of the algorithm devised by HP. HP build a vocabulary of 61,146 words that firms use to describe their products, and that identify product characteristics. For each firm  $i$ , HP use this vocabulary to construct a vector of word occurrences  $\mathbf{o}_i$ .

$$\mathbf{o}_i = \begin{bmatrix} o_{i,1} \\ o_{i,2} \\ \vdots \\ o_{i,61146} \end{bmatrix} \quad (3.1)$$

This vector is then normalized (i.e., divided by the Euclidean norm to obtain the counterpart of  $\mathbf{a}_i$ )

$$\mathbf{a}_i = \frac{\mathbf{o}_i}{\|\mathbf{o}_i\|}. \quad (3.2)$$

Finally, all  $\mathbf{a}_i$  vectors are dot-multiplied to obtain  $\mathbf{A}'\mathbf{A}$ :

$$\mathbf{A}'\mathbf{A} = \begin{bmatrix} \mathbf{a}'_1\mathbf{a}_1 & \mathbf{a}'_1\mathbf{a}_2 & \cdots & \mathbf{a}'_1\mathbf{a}_n \\ \mathbf{a}'_2\mathbf{a}_1 & \mathbf{a}'_2\mathbf{a}_2 & \cdots & \mathbf{a}'_2\mathbf{a}_n \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{a}'_n\mathbf{a}_1 & \mathbf{a}'_n\mathbf{a}_2 & \cdots & \mathbf{a}'_n\mathbf{a}_n \end{bmatrix} \quad (3.3)$$

To the extent that the word frequencies in the vocabulary constructed by HP correctly represent product characteristics, the resulting matrix is the exact empirical counterpart to  $\mathbf{A}'\mathbf{A}$ —the matrix of cross-price effects in our theoretical model. The fact that all publicly traded firms in the United States are required to file a 10-K form makes the HP dataset unique. It is the only dataset that covers the near entirety (97.8%) of the CRSP-Compustat universe.<sup>11</sup>

### 3.2 Ownership Data

In order to calculate the matrix of common ownership profit weights  $\mathbf{K}$ , we require the matrix of ownership shares  $\mathbf{S}$ . We obtain  $\mathbf{S}$  from two datasets of mutual fund holdings reported in form 13(f) filings. Form 13(f) is a mandatory filing of the Securities and Exchange Commission (SEC) in which institutional investors with assets in excess of \$100 million are required to report their holdings of US securities, including those of all US public corporations.

Our data covers the period 1994-2018. For the years 1999-2017 we use a dataset constructed by [Backus et al. \(2021b\)](#), who parsed the data contained in 13(f) forms. For the remaining years, we use 13(f) data from Thomson Reuters, obtained through the WRDS platform. We merge this data, using CUSIP codes, to the total amount of shares outstanding provided, for each firm, in Compustat.

By dividing the shareholdings of individual investors by the total number of shares outstanding, we obtain the normalized shares vector  $\mathbf{s}_i$ . We then apply equation (2.25) to compute the matrix  $\mathbf{K}$  of ownership shares.

Finally, we estimate the matrix of profit weights  $\mathbf{K}$  to account for the presence of unobserved investors as detailed in Appendix A. Constructing detailed ownership data for even the largest publicly-listed U.S. companies such as the constituents of the S&P500 is not without obstacles as noted by [Backus et al. \(2021b\)](#). This process is substantially more difficult for the entire universe of publicly-listed U.S. firms and without a correction to account for the presence of unobserved investors we would obtain a thick right tail of implausibly large  $\kappa_{ij}$ .

---

<sup>11</sup>One of HP's objectives in developing this dataset is to remedy two well-known shortcomings of the traditional industry classifications: (i) the inability to capture imperfect substitutability between products, which is the most salient feature of our model; and (ii) the fact that commonly used industry classifications, such as SIC and NAICS, are based on similarity in *production processes*, rather than in product characteristics. In other words, they are appropriate for estimating production functions, but unsuitable for proxying for the elasticity of substitution between different products.

### 3.3 Calibration and Identification

There are two crucial steps required to take our model to the data and to perform counterfactual analysis. First, we need to calibrate the parameters  $\alpha$  and  $\delta$ . Second, we have to identify the quantity vector  $\mathbf{q}$ , the price vector  $\mathbf{p}$ , the cost intercepts  $\mathbf{c}$ , and finally the demand intercepts  $\mathbf{b}$ .

We re-write the cost function as

$$h_i = \tilde{c}_i \left( \frac{q_i}{k_i^\theta} \right) + \frac{\tilde{\delta}}{2} \left( \frac{q_i}{k_i^\theta} \right)^2 \quad (3.4)$$

where, by definition:

$$c_i = \frac{\tilde{c}_i}{k_i^\theta} \quad \text{and} \quad \delta_i = \frac{\tilde{\delta}}{k_i^{2\theta}} \quad (3.5)$$

We assume that  $\tilde{\delta}$  is constant across firms and over time thereby reducing the dimensionality of the cost parameter vector to one  $(\tilde{\delta})$ .

We take the calibrated parameters for  $\alpha$  and  $\tilde{\delta}$  directly from [Pellegrino \(2019\)](#)—0.05 and 6.3 respectively—and we check that our model produces an equally good fit of markups and cross-price elasticity data. In Appendix D we document how well our model matches the non-targeted moments.

To identify  $\mathbf{q}$  we use the fact that we can write the vector of profits in terms of profits, and the matrices  $(\Delta, \Sigma, \mathbf{K})$ , which are already measured or calibrated:

$$\pi = \text{diag}(\mathbf{q}) \left( \mathbf{I} + \frac{1}{2} \Delta + \mathbf{K} \circ \Sigma \right) \mathbf{q} \quad (3.6)$$

While the equation above does not yield a closed-form solution, we can solve for  $\mathbf{q}$  numerically. Prices  $p_i$  are then obtained by dividing revenues  $p_i q_i$  by output  $q_i$ . Finally, the demand and marginal cost intercepts are identified as follows:

$$c_i = \frac{h_i}{q_i} - \frac{\delta}{2} q_i; \quad \mathbf{b} = (2\mathbf{I} + \Delta + \Sigma + \mathbf{K} \circ \Sigma) \mathbf{q} + \mathbf{c} \quad (3.7)$$

## 4 Empirical Results

Our empirical analysis proceeds in two steps. First, we describe the salient features of the data on product similarity and common ownership. Second, we report the empirical model estimates of welfare, consumer surplus, and profit and their evolution over time.

## 4.1 Product Similarity and Common Ownership

### 4.1.1 Network Structure of Product Similarity and Common Ownership

We begin our empirical analysis by visualizing the network structure of product similarity and common ownership. We first visualize the network structure of HP's dataset. We reduce the dimensionality of the dataset from 61,146 (the number of words in the HP's vocabulary) to two and use the algorithm of [Fruchterman and Reingold \(1991\)](#), henceforth FR, which is widely used in network science to visualize weighted networks.<sup>12</sup>

Every publicly traded firm in 2004 is a dot in the each of the two panels of Figure 2. In the left panel, firm pairs that have a high cosine product similarity are closer and are joined by a thicker line. Two patterns are particularly noteworthy. First, the distribution of firms over the space of product characteristics is uneven. Some areas in the left panel of Figure 2 are significantly more densely populated with firms than others. Second, the network displays a pronounced community structure because large groups of firms tend to cluster in certain areas of the network.

We repeat the same exercise for the network of ownership links between all the companies in our sample. As before, we reduce the dimensionality of the dataset from 3,126 (the number of investors) to two and use the FR algorithm to visualize the network in the right panel of Figure 2. Firm pairs that have large ownership weights between them appear closer, and are joined by a thicker line. Conversely, firms that are less similar in their ownership are not joined, and are more distant. In contrast to the product similarity network depicted in Figure 2 the network does not exhibit a community structure, but instead has a distinct hub-and-spoke structure with a large proportion of firms sharing significant overlap and a remainder of largely unconnected firms at the periphery.

Because both networks are based on time-varying relationships between the different constituents of the universe of public companies, they are not static networks, but evolve over the course of our study period. However, the two networks differ markedly in their evolution over time. The network of product similarity does not change much as measured by the average value of  $\mathbf{a}_i' \mathbf{a}_j$  which is equal to 0.0171 in 1994 and slightly decreases to 0.0174 in 2018. In contrast, the average value of  $\kappa_{ij}$  is equal to 0.0021 in 1994 but rises almost sevenfold to 0.0146 in 2018.

### 4.1.2 Relationship between Product Similarity and Common Ownership

A crucial aspect of our empirical analysis is to document the empirical relationship between product similarity  $\Sigma$  and common ownership  $\mathbf{K}$  because this relationship governs the magnitude of the

---

<sup>12</sup>The algorithm models the network nodes as particles, letting them dynamically arrange themselves on a bidimensional surface as if they were subject to attractive and repulsive forces. One known shortcoming of this algorithm is that it is sensitive to the initial configurations of the nodes, and it can have a hard time uncovering the cluster structure of large networks. To mitigate this problem, and to make sure that the cluster structure of the network is properly displayed, we pre-arrange the nodes using the OpenOrd algorithm (which was developed for this purpose) before running FR.

FIGURE 2: NETWORK VISUALIZATION

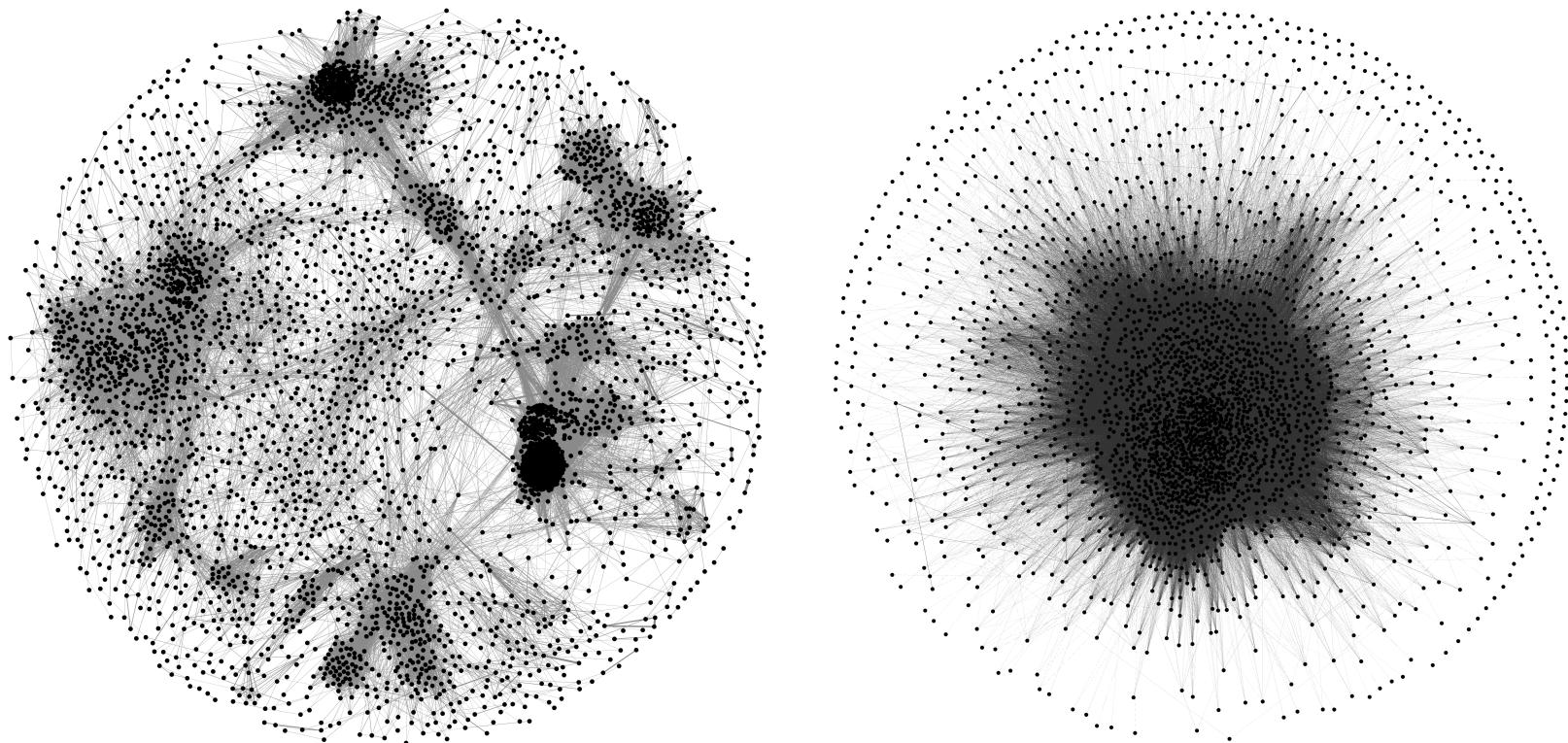


FIGURE NOTES: The diagrams are two-dimensional representations of the network of product similarities (left panel) computed by [Hoberg and Phillips \(2016\)](#) and of the network of ownership shares (right panel). Both networks are used in the estimation of the model presented in Section 2. The data cover the universe of publicly-listed firms in 2004. Firm pairs that have thicker links are closer in product market space and closer in ownership space, respectively. These distances are computed in spaces that have approximately 61,000 and 3,100 dimensions, respectively. To plot these high-dimensional objects over a plane, we apply the gravity algorithm of [Fruchterman and Reingold \(1991\)](#).

welfare cost of common ownership. As can be seen from equation (2.31) it is the Hadamard product of  $\mathbf{K}$  and  $\boldsymbol{\Sigma}$  that determines how much the realized quantity choices of firms under Cournot competition with common ownership differ from the standard benchmarks of standard Cournot without common ownership in equation (2.33) and monopoly in equation (2.35).

FIGURE 3: PRODUCT SIMILARITY AND PROFIT WEIGHTS (2018)

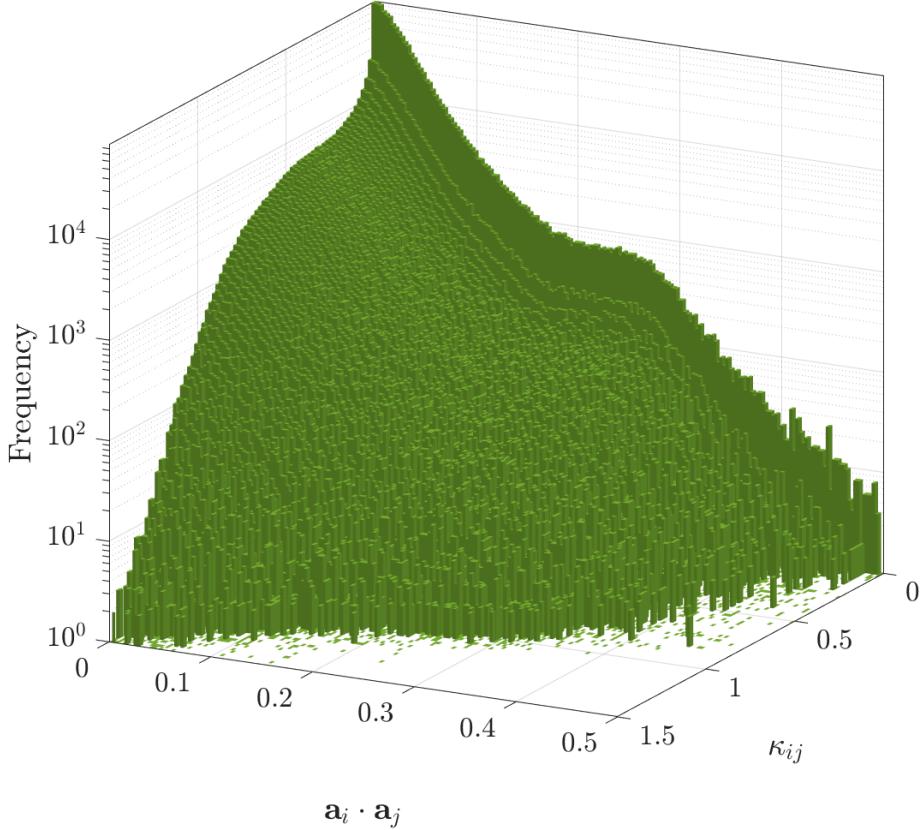


FIGURE NOTES: The figure reports a histogram of the joint distribution of product similarity  $\mathbf{a}_i \cdot \mathbf{a}_j$  and profit weights  $\kappa_{ij}$  for all firm  $ij$  pairs in 2018.

Figure 3 plots the histogram of the joint distribution of the product similarity  $\mathbf{a}_i \cdot \mathbf{a}_j$  and the common ownership weight  $\kappa_{ij}$  for any firm pair  $i$  and  $j$  in 2018. Although each product similarity pair  $\mathbf{a}_i \cdot \mathbf{a}_j$  is symmetric, the common ownership weight  $\kappa_{ij}$  is not symmetric. We therefore plot each pair of firm  $i$  and  $j$  twice.

A large proportion of firm pairs has little product similarity and little common ownership between them. The complete absence of overlap is relatively more pronounced in ownership than in product similarity space as evidenced by the discontinuous jump at 0 for  $\kappa_{ij}$ . However, a sizable proportion of firm pairs overlaps considerably in both product similarity and ownership space. There is no clear relationship between product similarity and common ownership. The correlation between the two variables in 2018 is 0.0034. This means that common ownership is not much more

pronounced for firms that are more similar in product space.

Finally, the figure also shows that a small proportion of  $\kappa_{ij}$  has values greater than 1. Such values of  $\kappa$  exceeding 1 lead to owners placing more weight on the profits of the other firm  $j$  than on the profits of their own firm  $i$ . This makes it possible for common ownership to create incentives for the “tunneling” of profits from one firm to another (Johnson et al., 2000). However, the proportion of these firms is sufficiently small such that even if we restrict all  $\kappa_{ij}$  to be strictly smaller than 1, the estimates of our model are essentially unchanged.

## 4.2 Welfare, Consumer Surplus, and Profit Estimates

We now present the results of the empirical estimation of our model. These baseline estimates assume that investors exert influence in proportion to their ownership shares and that firms set quantities in accordance with the objective function given in equation (2.23).

We first compute total surplus and decompose it into profits and consumer surplus as reported in Table 1 for 2018, the most recent year in our sample. These calculations are based on the assumption that the observed equilibrium is the Cournot-Nash equilibrium under common ownership (column 1) of our model in Section 2. In columns 2, 3, and 4 we report the counterfactual estimates based on the alternative model assumptions. Table 2 in the appendix reports the same estimates for 1994, the first year of our sample. Additionally, Table 3 in the appendix reports the estimates when all  $\kappa_{ij}$  are restricted to be smaller than 1.

We estimate that in 2018 under *Common Ownership* publicly-listed firms earn an aggregate economic profit of \$5.639 trillion, consumers gain a surplus of \$3.314 trillion, and the estimated total surplus is equal to \$8.953 trillion. 63% of the total surplus produced is appropriated by the companies in the form of oligopoly profits under common ownership while the remaining 37% accrues to consumers. It is instructive to put these estimates into context by comparing them to the GDP of U.S. corporations in the same year which is around \$11 trillion. The difference between GDP and total surplus computed here is that total surplus is twofold. Total surplus does not include the value of labor input, but it does include the value of inframarginal consumption. In contrast, GDP includes the value of labor input but not the inframarginal value of consumption.<sup>13</sup>

The estimates for our two primary counterfactuals, *Cournot-Nash* and *Perfect Competition*, are reported in column 2 and 3. Comparing the estimates of these counterfactual models with those of the *Common Ownership* allocation in column 1 shows that the welfare costs of common ownership are significant, but not as large as the welfare costs of oligopoly. First, total surplus is slightly higher at \$9.374 trillion under oligopoly without common ownership (Cournot-Nash) and significantly higher at \$10.597 trillion under perfect competition. Thus, we estimate that in 2018 the deadweight loss of oligopoly amounts to about 11.5% of total surplus. On top of that, common

---

<sup>13</sup>Recall that in our model each unit of labor is paid exactly its marginal disutility and thus there is no inframarginal value of leisure.

TABLE 1: WELFARE ESTIMATES (2018)

Welfare Statistic	Variable	$\mathbf{q}^{\Xi}$	$\mathbf{q}^{\Psi}$	$\mathbf{q}^W$	$\mathbf{q}^{\Pi}$	Scenario
						Common Ownership Cournot-Nash Perfect Competition Monopoly
		(1)	(2)	(3)	(4)	
Total Surplus (US\$ trillions)	$W(\mathbf{q})$	8.953	9.374	10.597	8.484	
Aggregate Profits (US\$ trillions)	$\Pi(\mathbf{q})$	5.639	5.261	2.033	5.878	
Consumer Surplus (US\$ trillions)	$CS(\mathbf{q})$	3.314	4.113	8.565	2.606	
Total Surplus / Perfect Competition	$\frac{W(\mathbf{q})}{W(\mathbf{q}^W)}$	0.845	0.885	1.000	0.802	
Aggregate Profit / Total Surplus	$\frac{\Pi(\mathbf{q})}{W(\mathbf{q})}$	0.630	0.561	0.192	0.693	
Consumer Surplus / Total Surplus	$\frac{CS(\mathbf{q})}{W(\mathbf{q})}$	0.370	0.439	0.808	0.307	

TABLE NOTES: The table reports the model estimates of aggregate profits, consumer surplus, and total surplus for each of the counterfactual scenarios presented in Section 2.

ownership leads to an additional deadweight loss of 4% of total surplus.

Although the effects of oligopoly and common ownership on efficiency are considerable, their respective distributional effects are even more substantial. Under perfect competition consumers capture a much larger share of the total surplus: \$8.565 trillion, more than double than in the Cournot-Nash (\$4.113 trillion) and the Common Ownership (\$3.314 trillion) allocations. This means that when firms price at marginal cost 80.8% of the total surplus accrues to consumers. In contrast, merely 43.9% and 37% of total surplus accrue to consumers under oligopoly without and with common ownership. Corporate profits, on the other hand, move exactly in the opposite direction. The aggregate profits under common ownership (\$5.639 trillion) are almost 3 times as large as those under perfect competition (\$2.033 trillion).

The comparison between *Common Ownership* in column 1 and *Cournot-Nash* in column 2 further allows us to focus on the distributional effects of common ownership on top of the effect of product market power due to oligopoly. Not only does common ownership in the economy lead to a total welfare loss of \$421 billion, but the welfare losses of common ownership fall entirely on consumers. Whereas common ownership raises aggregate profits by \$378 billion from \$5.261 trillion to \$5.639 trillion, it lowers consumer surplus by \$799 billion from \$4.113 trillion to \$3.314 trillion.

The final counterfactual we analyze is the *Monopoly* allocation for which we report the welfare estimates in column 4. Recall that under this allocation all firms are controlled by a single decision-maker who coordinates supply choices and maximizes aggregate firm profits. Aggregate surplus is equal to only \$8.484 trillion and thus significantly lower than in the common ownership equilibrium allocation. Despite the decrease in aggregate welfare, profits are markedly higher still at \$5.878 trillion. In contrast, consumer surplus is reduced to just \$2.606 trillion equal to 30.7% of the total surplus.

According to our estimates the market power due to oligopoly and common ownership of U.S. public firms has considerably effects on aggregate welfare, firm profits, and consumer welfare by generating resource misallocation and raising deadweight loss as well as by altering the division of surplus between producers and consumers.

### 4.3 Time Trends in Welfare, Consumer Surplus, and Profits

We now consider time trends in welfare, consumer surplus, and firm profits based on annual estimates obtained from mapping our model to Compustat data on a yearly basis. We are particularly interested in the welfare implications of the joint rise of product market and ownership concentration among publicly-listed U.S. companies for the period from 1994 to 2018.<sup>14</sup>

In Figure 4, we plot aggregate consumer surplus  $CS(\mathbf{q})$  (dark green area) and profits  $\Pi(\mathbf{q})$  (light green area) for every year between 1994 and 2018 for the observed *Common Ownership* equilibrium.

---

<sup>14</sup>Because our model uses both HP's time-varying product similarity data and time-varying ownership, our estimates account for how the product offering of U.S. public firms and their ownership has changed over time.

FIGURE 4: TOTAL SURPLUS OF U.S. PUBLIC FIRMS

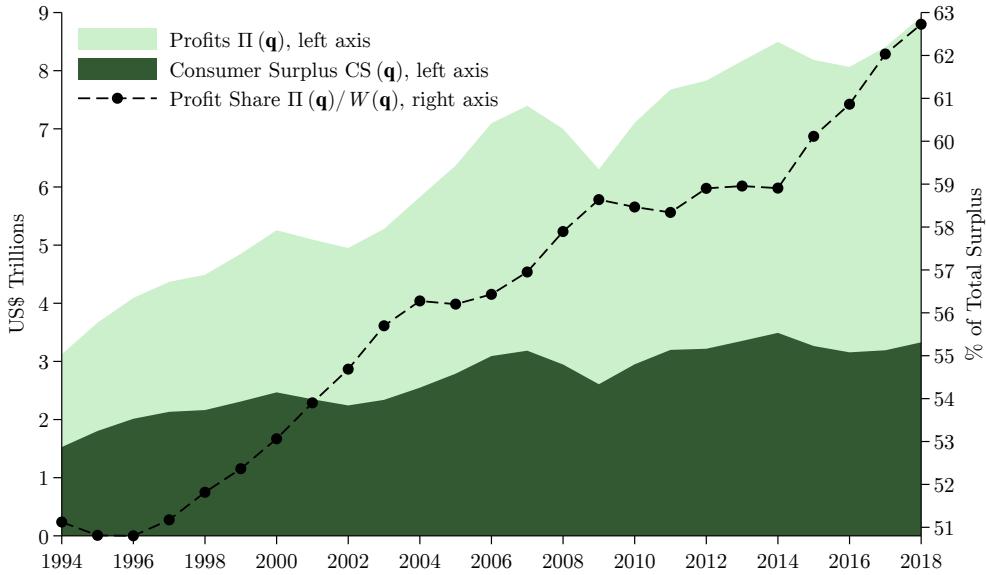


FIGURE NOTES: The figure plots the evolution of aggregate (economic) profits  $\Pi(\mathbf{q})$ , aggregate consumer surplus  $CS(\mathbf{q})$ , and total surplus  $W(\mathbf{q})$ , as defined in the model in Section 2. Profits as a percentage of total surplus ( $\Pi(\mathbf{q})/W(\mathbf{q})$ , black dotted line) are shown on the right axis. These statistics are estimated over the universe of the U.S. publicly-listed corporations. These surplus measures are gross of fixed costs.

The combined area represents total surplus  $W$ . On the right axis we also plot profits as a share of total surplus  $\Pi/W$  (dotted black line).

The total surplus produced by U.S. public corporations almost tripled between 1994 and 2018 from \$3.116 trillion to \$8.953 trillion. Most of the increase over this time period is due to the increase in profits while the gains in consumer surplus have been comparatively modest. Profits increased from \$1.597 trillion to \$5.639 trillion. Consumer surplus increased from \$1.519 trillion in 1994 to \$3.314 trillion in 2018. Because of these opposing shifts, the profit share of surplus increased from 51.2% of total surplus to 63%, but a significantly lower share of the surplus generated by public companies accrues to consumers, dropping from 48.8% of total surplus in 1994 to 37% in 2018.

To investigate the evolution of the profit share in greater detail and to decompose the separate effects of oligopoly and common ownership we plot the profit share of total surplus under Cournot with and without common ownership in Figure 5. Under standard Cournot without common ownership (dark green line) the increase in the profit share is significantly less pronounced than under Cournot with common ownership (light green line). Under standard Cournot the profit share only increases by 5.5 percentage points from 50.6% to 56.1%. In contrast, the increase in the profit share under common ownership is almost twice as large. The profit share increases by almost 12 percentage points from 51.2% to 63%.

Figure 6 plots the respective percentage gains in total surplus from moving from the standard

FIGURE 5: PROFIT SHARE OF TOTAL SURPLUS

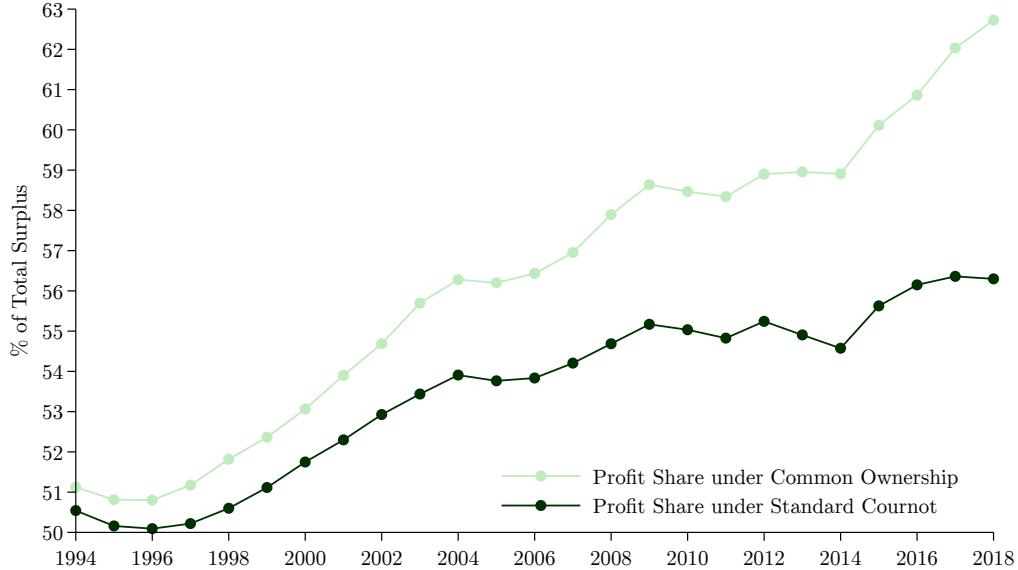


FIGURE NOTES: The figure plots the profit share under standard Cournot (dark green line) and Cournot with common ownership (light green line) between 1994 and 2018.

FIGURE 6: DEADWEIGHT LOSS

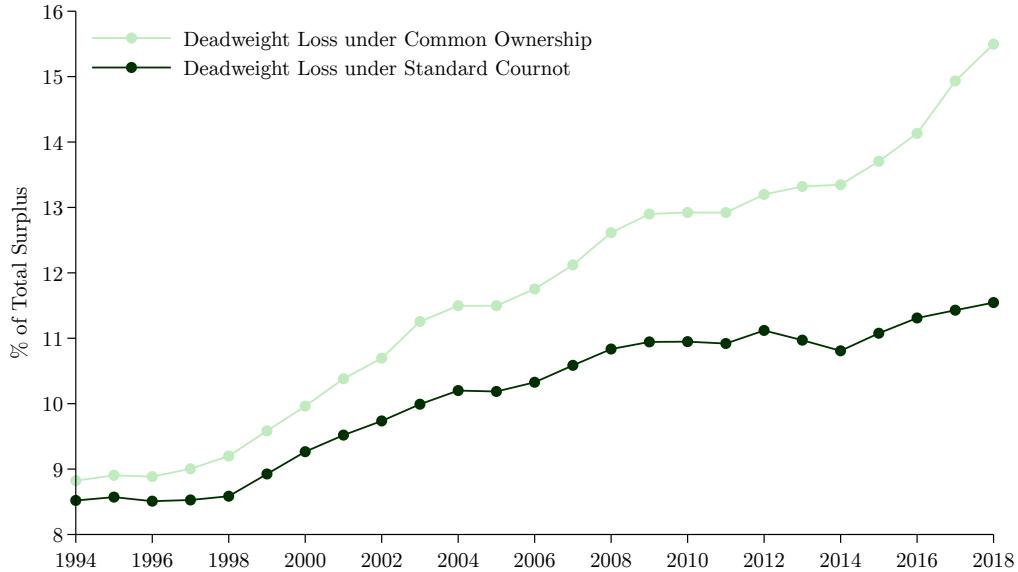


FIGURE NOTES: The figure plots the estimated deadweight loss (DWL) of oligopoly and of oligopoly and common ownership, between 1994 and 2018. The dark green line is the DWL of oligopoly, the % difference in total surplus between the Cournot equilibrium and the Perfect Competition scenario. The light green line is the % difference between the Cournot Common Ownership equilibrium and the Perfect Competition scenario. These surplus measures are gross of fixed costs.

Cournot equilibrium  $\mathbf{q}^{\Psi}$  and from the Cournot with common ownership equilibrium  $\mathbf{q}^{\Xi}$  to the first-best perfect competition equilibrium  $\mathbf{q}^W$ . These are the deadweight losses of oligopolistic behavior (dark green line) and of the combination of oligopolistic behavior and common ownership (light green line). Their respective trends closely mimic those of the profit shares of total surplus under both of these regimes. The deadweight losses increase from 8.5% and 8.8% in 1994 to 11.5% and 15.5% in 2018. This suggests that both the impact of oligopoly and the impact of common ownership on surplus creation have increased considerably over the last two decades.

The primary focus of our paper is to consider the welfare impact of common ownership over and above the impact of oligopoly. The left panel of Figure 7 plots the evolution of the deadweight loss that is solely due to the presence of common ownership. Specifically, the figure plots the difference between the two lines in Figure 6. This is the difference between the % difference in total surplus between standard Cournot and perfect competition and the % difference in total surplus between Cournot with common ownership and perfect competition. Whereas the deadweight loss attributable to common ownership is relatively modest in 1994 (0.3% of total surplus), it increases more than tenfold over the course of our sample reaching 4% of total surplus in 2018. As a result, the increase in deadweight loss under Cournot with common ownership (Figure 6, light green line) from 8.8% in 1994 to 15.5% in 2018 is due in slightly larger part to common ownership (59.7% of the increase) than to standard oligopoly reasons (40.3%).

FIGURE 7: COMMON OWNERSHIP: DEADWEIGHT LOSS AND DISTRIBUTIONAL EFFECTS

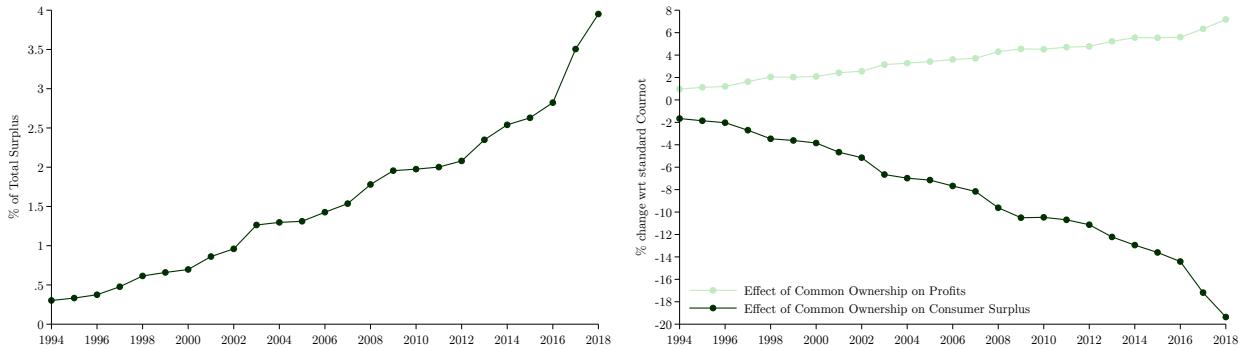


FIGURE NOTES: The figure plots the difference in deadweight loss (left panel), corporate profits, and consumer surplus (right panel) computed as % of the total surplus between Cournot with common ownership and standard Cournot from 1994 to 2018.

From an antitrust perspective we are particularly interested in the effect of common ownership on consumer surplus and its evolution over time. In the right panel of Figure 7 we plot the effect of common ownership on corporate profits and consumer surplus from 1994 to 2018. Common ownership raised corporate profits by 1% in 1994 and by 6.6% in 2018. At the same time, it lowered consumer surplus by less than 1.7% in 1994 but by almost 20% in 2018.

Taken together, our results suggest that compared to 1994 U.S. public firms have more market power in 2018 due to both standard oligopolistic reasons as well as due to an increase in ownership

concentration and overlap. According to our estimates this increase in aggregate market power negatively impacted both allocative efficiency and consumer welfare.

## 5 Robustness

### 5.1 Alternative Corporate Governance Assumptions

We now consider alternative assumptions of corporate governance that lead to different objective functions for the firm.

#### 5.1.1 Superproportional Influence of Large Investors

One of the assumptions of the governance model previously presented is that each firm  $i$  fully internalizes the proportional profit shares of its investors when choosing  $q_i$ . However, there are good reasons to believe that larger investors exert influence that exceeds the size of their stake. This could be because the corporate voting model is more akin to majoritarian than proportional representation ([Azar and Vives, 2021b](#)). Our model cannot speak to whether it is attention or voting rules that leads to superproportional influence of large investors. However, the results of [Gilje et al. \(2019\)](#) suggest that this influence function is concave. We therefore use the square root as an approximation.

The resulting influence-adjusted common ownership weights  $\tilde{\kappa}_{ij}$  are given by

$$\tilde{\kappa}_{ij} \stackrel{\text{def}}{=} \frac{\mathbf{s}'_i \mathbf{G}'_i \mathbf{s}_j}{\mathbf{s}'_i \mathbf{G}'_i \mathbf{s}_i} \quad (5.1)$$

where  $\mathbf{G}_i \stackrel{\text{def}}{=} \text{diag}(\mathbf{s}_i^{0.5})$  is the concave influence function.

#### 5.1.2 Blockholder Thresholds

Another common cutoff rule for investor influence is that of blockholders. The literature typically defines a blockholder as a shareholder holding 5% or more of a company's stock since this level triggers additional disclosure requirements ([Edmans and Holderness, 2017](#)). Such blockholders are essential in ensuring there is at least one owner who has the correct incentives to make residual decisions in a way that creates value. Their influence can come through direct intervention in a firm's operations (otherwise known as "voice") and through selling of shares if the firm underperforms (otherwise known as "exit").

We therefore construct blockholder-adjusted common ownership weights that recognize that investors can only exert influence if their ownership stake exceeds the 5% blockholder threshold in the company. These blockholder-adjusted common ownership weights are given by

$$\hat{\kappa}_{ij} \stackrel{\text{def}}{=} \frac{\mathbf{s}'_i \mathbf{B}'_i \mathbf{s}_j}{\mathbf{s}'_i \mathbf{s}_i} \quad (5.2)$$

where  $\mathbf{B}_i \stackrel{\text{def}}{=} \mathbb{1}_{s_{iz} \geq 0.05}(\mathbf{I}_n)$  is an indicator function that sets an investor  $z$ 's influence to zero unless their stake in company  $i$  exceeds the blockholder threshold of 5%.

### 5.1.3 Limited Investor Attention

One of the assumptions of the governance model previously presented is that each firm  $i$  fully internalizes the weighted profit shares of its investors when choosing  $q_i$ . While intuitively appealing, this assumption may not be entirely realistic. Agency problems between owners and managers, as analyzed in [Antón et al. \(2020\)](#), may attenuate or even exacerbate the anticompetitive effects of common ownership. Similarly, [Gilje, Gormley and Levit \(2019, henceforth GGL\)](#) have highlighted the importance of investor inattention in evaluating the extent of common ownership. Investor attention here refers to the extent to which firm owners incorporate strategic considerations related to common ownership in influencing company's decision. The rationale is that monitoring a firm's management and forcing it to incorporate strategic considerations related to common ownership requires a cost from the investor. Incurring this cost might not be optimal for every investor. This is likely to be the case for firm holdings that constitute only a small portion of a large diversified investor's overall portfolio.

Motivated by this consideration, GGL propose a corporate governance model of common ownership, which generalizes equation (2.22) by incorporating investor attention

$$\phi_i = \sum_{z=1}^Z s_{iz} \cdot [g_{iz} \cdot V_z + (1 - g_{iz}) \pi_i] \quad (5.3)$$

where  $g_{iz} \in [0, 1]$  represents the attention of investor  $z$  to company  $i$  which the investor partially owns. If  $g_{iz} = 0$  for all firm  $i$  investor  $z$  pairs, this objective function is identical to standard own firm profit maximization. At the other extreme, if  $g_{iz} = 1$  it is identical to the common ownership objective function in equation (2.23). GGL provide empirical evidence that the investor attention is an increasing and concave function of  $\beta_{iz}$ , the share of company  $i$  as a percentage of the total portfolio held by investor  $z$

$$\beta_{iz} = \frac{v_{iz}}{\sum_i v_{iz}} \quad (5.4)$$

where  $v_{iz}$  is the market value of the stake held by investor  $z$  in company  $i$ . Hence, they rewrite the attention weight  $g_{iz}$  as a function of  $\beta_{iz}$  such that  $g_{iz} = g(\beta_{iz})$  where  $g$  is a continuous function that maps the interval  $[0, 1]$  on itself. Because we are in a static model the market value of investor  $i$ 's stake  $v_{iz}$  is equal to the share of the profits  $s_{iz}\pi_i$ , equation (5.4) simplifies to

$$\beta_{iz} = \frac{s_{iz}\pi_i}{\sum_{i=1}^n s_{iz}\pi_i}. \quad (5.5)$$

Although firm profits are endogenously determined and depend on the attention that investors pay to firms in their portfolio, when allocating their attention to all the different firms in their

portfolio we assume that investors take the market values of these firms as given. This yields the attention-weighted profit weights  $\tilde{\kappa}_{ij}$  given by

$$\tilde{\kappa}_{ij} \stackrel{\text{def}}{=} \frac{\mathbf{s}'_i \mathbf{G}'_i \mathbf{s}_j}{\mathbf{s}'_i \mathbf{G}'_i \mathbf{s}_i} \quad \text{where} \quad \mathbf{G}_i \stackrel{\text{def}}{=} \begin{bmatrix} g(\beta_{i1}) & 0 & \cdots & 0 \\ 0 & g(\beta_{i2}) & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & g(\beta_{iZ}) \end{bmatrix} \quad (5.6)$$

We estimate  $\tilde{\mathbf{K}}$  by directly applying the attention weights estimated by GGL to our own  $\mathbf{K}$  matrix.

#### 5.1.4 Empirical Results

We now compare the results of these alternative governance assumptions to our benchmark case which assumes Rotemberg (i.e., proportional) common ownership weights.

FIGURE 8: COMMON OWNERSHIP DWL UNDER ALTERNATIVE GOVERNANCE

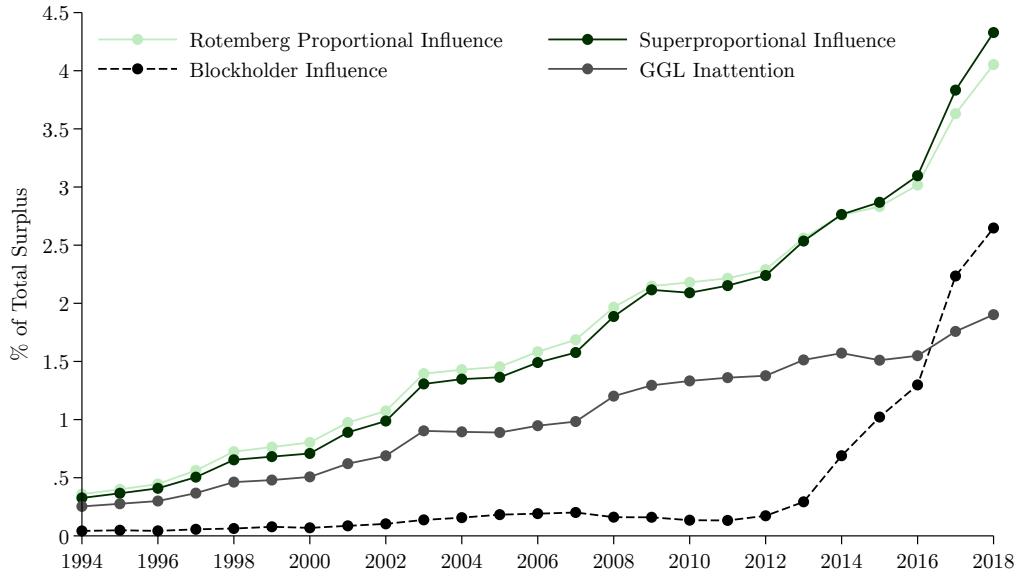


FIGURE NOTES: The figure plots the deadweight loss of common ownership computed as % of the total surplus under proportional, superproportional and blockholder influence from 1994 to 2018.

In Figure 8 we plot the evolution of the deadweight loss that is due to the presence of common ownership under different governance assumptions. Whereas superproportional influence of large investors leads to a deadweight loss that is quite similar though slightly larger than under proportional common ownership throughout our sample, the effect of common ownership with blockholder thresholds is much smaller in the early years of our sample. Until 2013 the deadweight loss of blockholder common ownership is well below 0.5% of total surplus. However, after that it rises rapidly to as high as 2.5% of total surplus at the end of our sample period. This in large part due to the

increasingly large ownership stakes of the biggest asset management companies in all publicly listed firms. Until the mid-2010s their ownership stakes rarely exceeded the 5% blockholder threshold, but by the end of the sample they constitute the top shareholders for almost all publicly listed firms. For example, today both BlackRock and Vanguard are among the top five shareholders of almost 70 percent of the largest 2,000 publicly traded firms in the US whereas twenty years ago that number was zero percent for both firms. Finally, the deadweight loss estimates of common ownership under the GGL governance hover between blockholder and proportional influence for the two decades during which the data required for the computation of these estimates are available. Even under GGL governance assumptions common ownership leads to a deadweight loss of almost 2% of total surplus.

FIGURE 9: DISTRIBUTIONAL EFFECTS UNDER ALTERNATIVE GOVERNANCE (1994-2018)

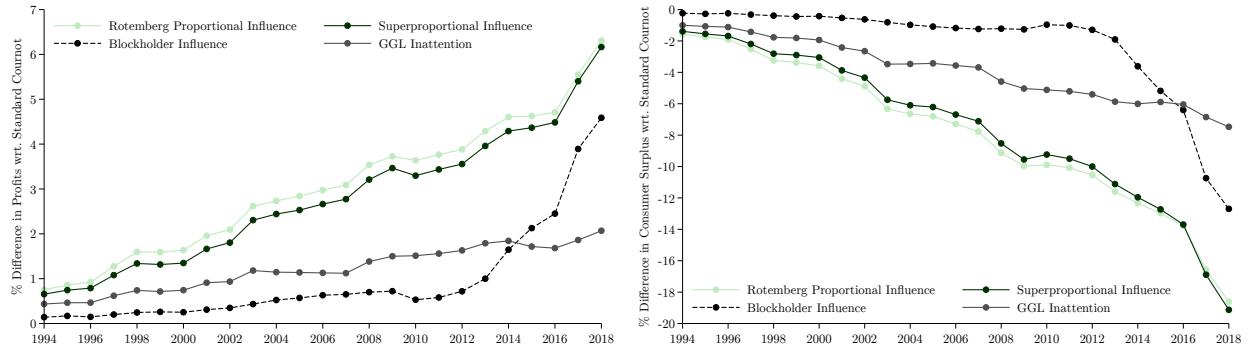


FIGURE NOTES: The figure plots the profit (left panel) and consumer surplus (right panel) difference between standard Cournot and Cournot with common ownership under proportional, superproportional and blockholder influence computed as % of the total surplus from 1994 to 2018.

In Figure 9 similar patterns emerge for the distributional consequences of common ownership on firm profits (left panel) and consumer surplus (right panel). Common ownership with superproportional influence leads to essentially identical increases in profits and decreases in consumer surplus as our benchmark case with Rotemberg proportional weights. Common ownership with blockholder influence thresholds have little impact on either measure until about 2012. However, even with blockholder thresholds common ownership raises firm profits by almost 5% of total surplus and lowers consumer surplus by almost 13% in 2018. Under GGL governance assumptions common ownership has more muted distributional consequences. Common ownership modestly raises firm profits by approximately 2%, but still leads to a significant reduction of consumer surplus of almost 7% in 2018.

Thus, even under alternative governance assumptions common ownership leads to a sizeable deadweight loss that is increasing over time as well as considerable distributional consequences that transfer rents from consumers to producers.

## 5.2 Fixed Costs and Intangible Capital

Our definitions of aggregate profits  $\Pi$  and total surplus  $W$  are *gross* of fixed costs  $F = \sum_i f_i$ . As a natural robustness check, it is instructive to study how the evolution of the profits and total welfare changes if we subtract  $F$  from  $\Pi$  and  $W$ . This allows us to investigate whether the higher economic profits are somehow justified by higher fixed costs.

In Figure 11 and 12 in the appendix we show the evolution of the profit share and the deadweight loss after redefining  $\Pi$  and  $W$  to be computed net of fixed costs. In contrast to Figure 5 and 6, when fixed costs are subtracted the profit share of total surplus in Figure 11 increases more dramatically because it starts from a lower level in 1994.

One thorny issue regarding the estimation of fixed costs is the treatment of Selling, General & Administrative (SGA). In Compustat, this item includes miscellaneous costs that include R&D expenditures and are not directly linked to production. SGA also partly includes investments in *intangible capital*, and therefore should not be treated as overhead but should be capitalized. Peters and Taylor (2017) propose a measure of intangible capital for Compustat which treats R&D expenditures and 30% of the remaining portion of SGA as investment in intangible capital. Following their procedure we obtain an alternative measure of fixed costs:

$$f_i = (\text{SGA}_i - \text{R\&D}_i) \times 0.7 + (\text{PPE}_i + \text{Intangible Capital}_i) \times \text{User Cost of Capital} \quad (5.7)$$

Figure 13 and 14 use this alternate measure of fixed costs in which intangible investments are capitalized rather than expensed. Our results are largely unaffected by using this alternate measure.

## 6 Conclusions

In this paper we provide the first quantification of the welfare and distributional effects of common ownership at the macroeconomic rather than just the industry level. We develop a general equilibrium model of oligopoly in which firms are connected through two large networks of product similarity and ownership overlap. Our baseline empirical estimates indicate that the rise of common ownership from 1994 to 2018 has led to considerable and increasing deadweight losses, amounting to 0.3% of the total surplus in 1994 and as much as 4% by 2018. In addition, the increase in common ownership resulted in a significantly lower share of total surplus accruing to consumers. The key insights of our findings also extend to alternative corporate governance assumptions such as superproportional influence, blockownership thresholds, and limited investor attention.

The economically large impact of common ownership in several industries across the entire economy as well as its continuing increase suggest that antitrust policy and financial regulation may have to address this new challenge. Our counterfactual analyses show that recent policy proposals aimed at curtailing the anticompetitive effects of common ownership could increase consumer welfare and reduce deadweight loss.

Although we assume a particular form of firm conduct (i.e., quantity choices in Cournot product market oligopoly) and therefore focus on a particular set of welfare implications of common ownership (i.e., static unilateral effects on product market rivalry), our framework can be applied to other forms of firm conduct to analyze different channels. For example, recent theoretical and empirical contributions to the growing literature on common ownership suggest that common ownership may also affect labor market power ([Azar and Vives, 2021a](#)), innovation ([Antón et al., 2018; Eldar et al., 2020](#)), entry ([Newham et al., 2019; Xie and Gerakos, 2020](#)), cost efficiency ([Antón et al., 2020](#)), and incentives to collude ([Pawliczek et al., 2019; Shekita, 2021](#)). We leave the empirical quantification of these channels to future research.

## References

- Acemoglu, Daron, Asuman Ozdaglar, and Alireza Tahbaz-Salehi**, “Microeconomic origins of macroeconomic tail risks,” *American Economic Review*, 2017, 107 (1), 54–108.
- , **Vasco M Carvalho, Asuman Ozdaglar, and Alireza Tahbaz-Salehi**, “The network origins of aggregate fluctuations,” *Econometrica*, 2012, 80 (5), 1977–2016.
- Amiti, Mary, Oleg Itskhoki, and Jozef Konings**, “International shocks, variable markups, and domestic prices,” *Review of Economic Studies*, 2019, 86 (6), 2356–2402.
- Ángel L. López and Xavier Vives**, “Overlapping Ownership, R&D Spillovers, and Antitrust Policy,” *Journal of Political Economy*, 2019, 127 (5), 2394–2437.
- and —, “Overlapping Ownership, R&D Spillovers, and Antitrust Policy,” *Journal of Political Economy*, 2019, 127 (5), 2394–2437.
- Antón, Miguel, Florian Ederer, Mireia Giné, and Martin C Schmalz**, “Common ownership, competition, and top management incentives,” *Yale SOM Working Paper*, 2020, 1328.
- , —, —, and **Martin Schmalz**, “Innovation: The Bright Side of Common Ownership?,” *SSRN Working Paper 3099578*, 2018.
- Autor, David, David Dorn, Lawrence F Katz, Christina Patterson, and John Van Reenen**, “The fall of the labor share and the rise of superstar firms,” *Quarterly Journal of Economics*, 2020, 135 (2), 645–709.
- Azar, José**, “A new look at oligopoly: Implicit collusion through portfolio diversification,” *Ph.D. Thesis, Princeton University*, 2012.
- Azar, José**, “The Common Ownership Trilemma,” *University of Chicago Law Review*, 2020, 87 (2), 263–296.
- Azar, José and Xavier Vives**, “General Equilibrium Oligopoly and Ownership Structure,” *Econometrica*, 2021.
- Azar, José and Xavier Vives**, “Revisiting the Anticompetitive Effects of Common Ownership,” Available at *SSRN 3805047*, 2021.
- , **Martin Schmalz, and Isabel Tecu**, “Anticompetitive effects of common ownership,” *Journal of Finance*, 2018, 73 (4), 1513–1565.
- Backus, Matthew, Christopher Conlon, and Michael Sinkinson**, “The Common Ownership Hypothesis: Theory and Evidence,” *Economic Studies at Brookings*, 2019.
- , —, and —, “Common Ownership and Competition in the Ready-To-Eat Cereal Industry,” *NBER Working Paper*, 2021.

- , —, and —, “Common ownership in America: 1980–2017,” *American Economic Journal: Microeconomics*, 2021, 13 (3), 273–308.
- Ballester, Coralio, Antoni Calvó-Armengol, and Yves Zenou**, “Who’s Who in Networks. Wanted: The Key Player,” *Econometrica*, 2006, 74 (5), 1403–1417.
- Baqae, David and Emmanuel Farhi**, “The Darwinian Returns to Scale,” *NBER Working Paper*, 2020.
- Baqae, David Rezza and Emmanuel Farhi**, “Productivity and misallocation in general equilibrium,” *Quarterly Journal of Economics*, 2020, 135 (1), 105–163.
- Ben-David, Itzhak, Francesco Franzoni, Rabih Moussawi, and John Sedunov**, “The granular nature of large institutional investors,” *Management Science*, 2020.
- Bergson, Abram**, “On Monopoly Welfare Losses,” *American Economic Review*, 1973, 63 (5), 853–870.
- Bertrand, Marianne and Emir Kamenica**, “Coming apart? Cultural distances in the United States over time,” *NBER Working Paper*, 2018.
- Bloom, Nicholas, Mark Schankerman, and John Van Reenen**, “Identifying technology spillovers and product market rivalry,” *Econometrica*, 2013, 81 (4), 1347–1393.
- Boller, Lysle and Fiona Scott Morton**, “Testing the Theory of Common Stock Ownership,” *NBER Working Paper*, 2020.
- Carvalho, Vasco M**, “From micro to macro via production networks,” *Journal of Economic Perspectives*, 2014, 28 (4), 23–48.
- and Alireza Tahbaz-Salehi, “Production networks: A primer,” *Annual Review of Economics*, 2019, 11, 635–663.
- , Makoto Nirei, Yukiko U Saito, and Alireza Tahbaz-Salehi, “Supply chain disruptions: Evidence from the Great East Japan Earthquake,” *Quarterly Journal of Economics*, 2021, 136 (2), 1255–1321.
- Covarrubias, Matias, Germán Gutiérrez, and Thomas Philippon**, “From Good to Bad Concentration? US Industries over the past 30 years,” *NBER Macroeconomics Annual*, 2020, 34 (1), 1–46.
- Cowling, Keith and Dennis C. Mueller**, “The Social Costs of Monopoly Power,” *Economic Journal*, 1978, 88 (352), 727–748.
- Drèze, Jacques H.**, “Investment under private ownership: optimality, equilibrium and stability,” in “Allocation under uncertainty: equilibrium and optimality,” Springer, 1974, pp. 129–166.
- Edgeworth, Francis Ysidro**, *Mathematical psychics: An essay on the application of mathematics to the moral sciences*, Vol. 10, Kegan Paul, 1881.
- Edmans, Alex and Clifford G Holderness**, “Blockholders: A survey of theory and evidence,” *The handbook of the economics of corporate governance*, 2017, 1, 541–636.
- Edmond, Chris, Virgiliu Midrigan, and Daniel Yi Xu**, “How costly are markups?,” *NBER Working Paper*, 2018.
- Eldar, Ofer, Jillian Grennan, and Katherine Waldock**, “Common ownership and startup growth,” *Duke Law School Public Law & Legal Theory Series*, 2020.
- Eppe, Dennis**, “Hedonic prices and implicit markets: estimating demand and supply functions for differentiated products,” *Journal of political economy*, 1987, 95 (1), 59–80.
- European Competition Commission**, “Commission Decision M.7932 – Dow/DuPont,” *Competition Committee*, 2017, March (3). Available at [https://ec.europa.eu/competition/mergers/cases/decisions/m7932\\_13668\\_3.pdf](https://ec.europa.eu/competition/mergers/cases/decisions/m7932_13668_3.pdf).
- Federal Trade Commission**, “Competition and Consumer Protection in the 21st Century,” *FTC Hearings*, 2018, December (6). Available at [https://www.ftc.gov/system/files/documents/public\\_events/1422929/ftc\\_hearings\\_session\\_8\\_transcript\\_12-6-18\\_0.pdf](https://www.ftc.gov/system/files/documents/public_events/1422929/ftc_hearings_session_8_transcript_12-6-18_0.pdf).

- Fruchterman, Thomas MJ and Edward M Reingold**, “Graph drawing by force-directed placement,” *Software: Practice and experience*, 1991, 21 (11), 1129–1164.
- Gilje, Erik P, Todd A Gormley, and Doron Levit**, “The Rise of Common Ownership,” Technical Report, Working Paper, University of Pennsylvania and Washington University in St. Louis 2018.
- , —, and —, “Who’s paying attention? Measuring common ownership and its impact on managerial incentives,” *Journal of Financial Economics*, 2019.
- Grossman, Sanford J. and Oliver Hart**, “A theory of competitive equilibrium in stock market economies,” *Econometrica*, 1979, pp. 293–329.
- Grullon, Gustavo, Yelena Larkin, and Roni Michaely**, “Are US industries becoming more concentrated?,” *Review of Finance*, 2019, 23 (4), 697–743.
- Harberger, Arnold C.**, “Monopoly and Resource Allocation,” *American Economic Review*, 1954, 44 (2), 77–87.
- Hoberg, Gerard and Gordon Phillips**, “Text-based network industries and endogenous product differentiation,” *Journal of Political Economy*, 2016, 124 (5), 1423–1465.
- Ivaldi, Marc, Bruno Jullien, Patrick Rey, Paul Seabright, and Jean Tirole**, “The economics of tacit collusion,” *Report for DG Comp, European Commission*, 2003.
- , —, —, —, and —, “The economics of unilateral effects,” *Report for DG Comp, European Commission*, 2003.
- Johnson, Simon, Rafael La Porta, Florencio Lopez de Silanes, and Andrei Shleifer**, “Tunneling,” *American Economic Review*, 2000, 90 (2), 22–27.
- Kamerschen, David R.**, “An estimation of the “welfare losses” from monopoly in the American economy,” *Economic Inquiry*, 1966, 4 (3), 221–236.
- Lancaster, Kelvin J.**, “A New Approach to Consumer Theory,” *Journal of Political Economy*, 1966, 74 (2), 132–157.
- Li, Xuelin, Tong Liu, and Lucian A. Taylor**, “Do Venture Capitalists Stifle Competition?,” Available at SSRN 3479439, 2020.
- Loecker, Jan De, Jan Eeckhout, and Gabriel Unger**, “The rise of market power and the macroeconomic implications,” *Quarterly Journal of Economics*, 2020, 135 (2), 561–644.
- Matvos, Gregor and Michael Ostrovsky**, “Cross-ownership, returns, and voting in mergers,” *Journal of Financial Economics*, 2008, 89, 391–403.
- Monderer, Dov and Lloyd S Shapley**, “Potential games,” *Games and Economic Behavior*, 1996, 14 (1), 124–143.
- Newham, Melissa, Jo Seldeslachts, and Albert Banal-Estanol**, “Common Ownership and Market Entry: Evidence from Pharmaceutical Industry,” *DIW Berlin Discussion Paper*, 2019.
- OECD**, “Common Ownership by Institutional Investors and its Impact on Competition,” *Competition Committee*, 2017, December (7). Available at [https://one.oecd.org/document/DAF/COMP\(2017\)10/en/pdf](https://one.oecd.org/document/DAF/COMP(2017)10/en/pdf).
- Pawlczek, Andrea, A Nicole Skinner, and Sarah LC Zechman**, “Facilitating tacit collusion: a new perspective on common ownership and voluntary disclosure,” Available at SSRN 3382324, 2019.
- Pellegrino, Bruno**, “Product Differentiation and Oligopoly: a Network Approach,” *WRDS Research Paper*, 2019.
- Peters, Ryan H and Lucian A Taylor**, “Intangible capital and the investment-q relation,” *Journal of Financial Economics*, 2017, 123 (2), 251–272.
- Phillips, Noah Joshua**, “Taking stock: Assessing common ownership,” in “US Federal Trade Commissioner’s speech at Concurrences Review and NYU Stern: The Global Antitrust Economics Conference, New York” 2018.
- Rosen, Sherwin**, “Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition,” *Journal of Political Economy*, 1974, 82 (1), 34–55.

- Rotemberg, Julio**, “Financial transaction costs and industrial performance,” *MIT Sloan Working Paper*, 1984.
- Rubinstein, Ariel and Menahem E. Yaari**, “The competitive stock market as cartel maker: Some examples,” *LSE STICERD Working Paper*, 1983.
- Saidi, Farzad and Daniel Streitz**, “Bank Concentration and Product Market Competition,” *Review of Financial Studies*, 1 2021.
- Schmalz, Martin**, “Common Ownership Concentration and Corporate Conduct,” *Annual Review of Financial Economics*, 2018, 10.
- Shekita, Nathan**, “Interventions by Common Owners,” *Journal of Competition Law & Economics*, 2021.
- Solomon, Steven Davidoff**, “Rise of Institutional Investors Raises Questions of Collusion,” *New York Times*, 2016, April (12). Available at <https://www.nytimes.com/2016/04/13/business/dealbook/rise-of-institutional-investors-raisesquestions-of-collusion.html>.
- Syverson, Chad**, “Macroeconomics and market power: Context, implications, and open questions,” *Journal of Economic Perspectives*, 2019, 33 (3), 23–43.
- Ushchev, Philip and Yves Zenou**, “Price competition in product variety networks,” *Games and Economic Behavior*, 2018, 110, 226–247.
- Veblen, Thorstein**, *The Theory of the Leisure Class: An Economic Study of Institutions*, New York: Macmillan, 1899.
- Vestager, Margrethe**, “Competition in Changing Times,” *European Commission*, 2018, February (16). Available at [https://ec.europa.eu/commission/commissioners/2014-2019/vestager/announcements/competition-changing-times-0\\_en](https://ec.europa.eu/commission/commissioners/2014-2019/vestager/announcements/competition-changing-times-0_en).
- Xie, Jin and Joseph Gerakos**, “The Anticompetitive Effects of Common Ownership: The Case of Paragraph IV Generic Entry,” *AEA Papers and Proceedings*, May 2020, 110, 569–72.

# Appendices

## COMMON OWNERSHIP AND PRODUCT MARKET COMPETITION: A TALE OF TWO NETWORKS

**Florian Ederer (Yale) & Bruno Pellegrino (UMD)**

---

### A Unobserved Ownership Correction

In this appendix, we detail our methodology to estimate the matrix of profit weights  $\mathbf{K}$ , in a way that is robust to the presence of unobserved investors which would otherwise lead to a thick right tail of implausibly large  $\kappa_{ij}$ . We start by rewriting  $\kappa_{ij}$  in the following way:

$$\kappa_{ij} = \frac{\mathbf{s}'_i \mathbf{s}_j}{\text{IHII}_i} \quad (\text{A.1})$$

The key problem is to estimate the numerator and the denominator based on the fact that in 13F data we observe a limited set of investors. Let us denote with  $O$  the set of Observed Investors, and  $U$  the set of Unobserved Investors.

Importantly, the denominator of the vector  $\mathbf{s}_i$ , which is the total number of shares, includes both observed and unobserved investors, because it is taken from Compustat. Hence, typically, the observed  $s_{iz}$  will sum to a value less than one.

All the diagonal  $\kappa_{ii}$  are equal to one by construction and hence we can focus on the  $i \neq j$  case. Under the (conservative) assumption that there is zero overlap in ownership between  $i$  and  $j$  among unobserved investors:

$$\sum_{z \in U} s_{iz} s_{jz} = 0 \quad (\text{A.2})$$

we can compute the numerator of the equation above by simply ignoring the unobserved investors.

Estimating the denominator is slightly more complex. If we compute the IHII using observed investors only we obtain:

$$\widehat{\text{IHII}}_i = \sum_{k \in O} s_{iz}^2 \quad (\text{A.3})$$

a downward biased estimate of the IHII. For some firms, where few small investors are observed, this bias can be enormous, leading  $\kappa$  to exceed 10,000. Let us write the “true” IHII as

$$\text{IHII}_i^* = \sum_{z \in O} s_{iz}^2 + \sum_{z \in U} s_{iz}^2 \quad (\text{A.4})$$

Let  $S_{i(\mathcal{O})}$  and  $S_{i(\mathcal{U})}$  be the sum of shares for the observed and unobserved investors, respectively:

$$S_{i(\mathcal{O})} = \sum_{z \in \mathcal{O}} s_{iz} \quad S_{i(\mathcal{U})} = \sum_{z \in \mathcal{U}} s_{iz} \quad (\text{A.5})$$

and let  $s_{i(\mathcal{O})k}$  and  $s_{i(\mathcal{U})k}$  the shares owned by investor  $k$  as a share of the observed and unobserved ones, respectively:

$$s_{i(\mathcal{O})z} = \frac{1}{S_{i(\mathcal{O})}} \cdot \sum_{z \in \mathcal{O}} s_{iz} \quad s_{i(\mathcal{U})z} = \frac{1}{S_{i(\mathcal{U})}} \cdot \sum_{z \in \mathcal{U}} s_{iz} \quad (\text{A.6})$$

As a result we have

$$\begin{aligned} \text{IHHI}_i^* &= \sum_{z \in \mathcal{O}} (S_{i(\mathcal{O})} \cdot s_{i(\mathcal{O})k})^2 + \sum_{z \in \mathcal{U}} (S_{i(\mathcal{U})} \cdot s_{i(\mathcal{U})k})^2 \\ &= S_{i(\mathcal{O})}^2 \cdot \sum_{z \in \mathcal{O}} s_{i(\mathcal{O})k}^2 + S_{i(\mathcal{U})}^2 \cdot \sum_{z \in \mathcal{U}} s_{i(\mathcal{U})z}^2 \\ &= S_{i(\mathcal{O})}^2 \cdot \text{IHHI}_i^{\mathcal{O}} + S_{i(\mathcal{U})}^2 \cdot \text{IHHI}_i^{\mathcal{U}} \end{aligned}$$

where we have rewritten the terms in summation as the Herfindahl index among *observed* and *unobserved* investors only, respectively. By making the assumption that ownership concentration is identical among unobserved and observed investors ( $\text{IHHI}_i^{\mathcal{O}} = \text{IHHI}_i^{\mathcal{U}}$ ), and using the fact that

$$S_{i(\mathcal{U})} = 1 - S_{i(\mathcal{O})} \quad (\text{A.7})$$

the true Herfindahl index can be rewritten as:

$$\begin{aligned} \text{IHHI}_i^* &= \left[ S_{i(\mathcal{O})}^2 + (1 - S_{i(\mathcal{O})})^2 \right] \cdot \text{IHHI}_i^{\mathcal{O}} \\ &= \left[ S_{i(\mathcal{O})}^2 + (1 - S_{i(\mathcal{O})})^2 \right] \cdot \sum_{i \in \mathcal{O}} \left( \frac{1}{S_{i(\mathcal{O})}} s_i \right)^2 \\ &= \left[ 1 + \left( \frac{1 - S_{i(\mathcal{O})}}{S_{i(\mathcal{O})}} \right)^2 \right] \cdot \widehat{\text{IHHI}}_i \end{aligned}$$

## B Additional Tables and Figures

In this appendix we provide additional tables and figures.

TABLE 2: WELFARE ESTIMATES (1994)

Welfare Statistic	Variable	Scenario			
		(1) Common Ownership	(2) Cournot-Nash	(3) Perfect Competition	(4) Monopoly
Total Surplus (US\$ trillions)	$W(\mathbf{q})$	3.116	3.126	3.417	2.755
Aggregate Profits (US\$ trillions)	$\Pi(\mathbf{q})$	1.597	1.581	0.723	1.919
Consumer Surplus (US\$ trillions)	$CS(\mathbf{q})$	1.519	1.545	2.694	0.836
Total Surplus / Perfect Competition	$\frac{W(\mathbf{q})}{W(\mathbf{q}^W)}$	0.912	0.915	1.000	0.806
Aggregate Profit / Total Surplus	$\frac{\Pi(\mathbf{q})}{W(\mathbf{q})}$	0.512	0.506	0.212	0.697
Consumer Surplus / Total Surplus	$\frac{CS(\mathbf{q})}{W(\mathbf{q})}$	0.488	0.494	0.788	0.303

TABLE NOTES: The table reports the model estimates of aggregate profits, consumer surplus, and total surplus for each of the counterfactual scenarios presented in Section 2.

TABLE 3: WELFARE ESTIMATES (2017) FOR  $\kappa_{ij} \leq 1$ 

Welfare Statistic	Variable	Scenario			
		Common Ownership (1)	Cournot-Nash (2)	Perfect Competition (3)	Monopoly (4)
Total Surplus (US\$ trillions)	$W(\mathbf{q})$	8.406	8.752	9.881	7.922
Aggregate Profits (US\$ trillions)	$\Pi(\mathbf{q})$	5.234	4.923	1.935	5.493
Consumer Surplus (US\$ trillions)	$S(\mathbf{q})$	3.172	3.830	7.946	2.429
Total Surplus / Perfect Competition	$\frac{W(\mathbf{q})}{W(\mathbf{q}^W)}$	0.851	0.886	1.000	0.802
Aggregate Profit / Total Surplus	$\frac{\Pi(\mathbf{q})}{W(\mathbf{q})}$	0.623	0.562	0.196	0.693
Consumer Surplus / Total Surplus	$\frac{CS(\mathbf{q})}{W(\mathbf{q})}$	0.377	0.438	0.804	0.307

TABLE NOTES: The table reports the model estimates of aggregate profits, consumer surplus, and total surplus for each of the counterfactual scenarios presented in Section 2 restricting  $\kappa_{ij} \leq 1$ .

FIGURE 10: DISTRIBUTIONAL EFFECTS OF COMMON OWNERSHIP (1994-2018)

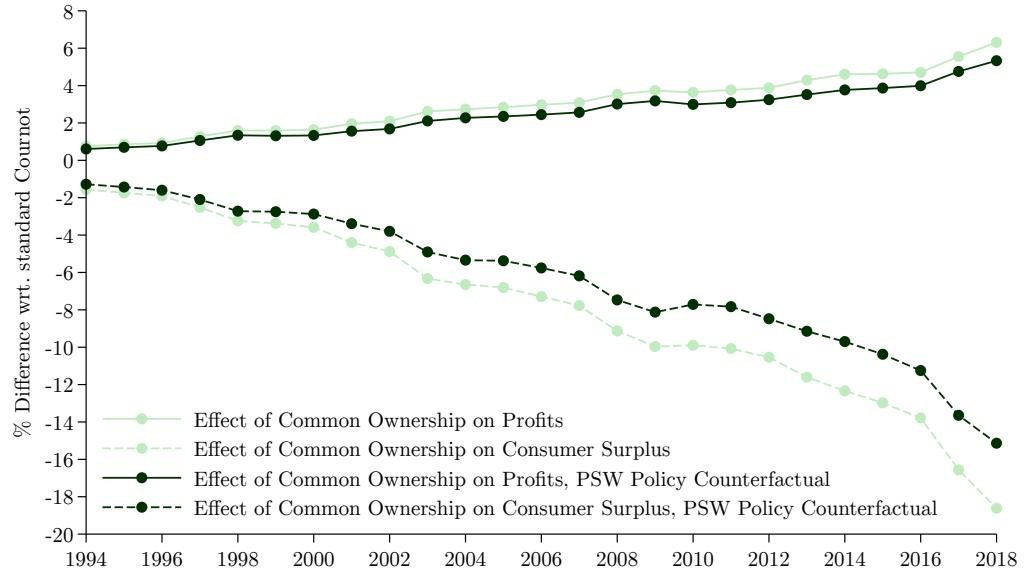


FIGURE NOTES: The figure plots the profit and consumer surplus difference between standard Cournot and Cournot with common ownership under proportional, superproportional and blockholder influence computed as % of the total surplus from 1994 to 2018.

## C Fixed Costs and Intangible Capital

In this appendix, we recompute our estimates of the evolution of the profit share and the deadweight loss over time using a different definition of aggregate profits that subtracts fixed costs.

FIGURE 11: PROFIT SHARE OF TOTAL SURPLUS NET OF FIXED COSTS

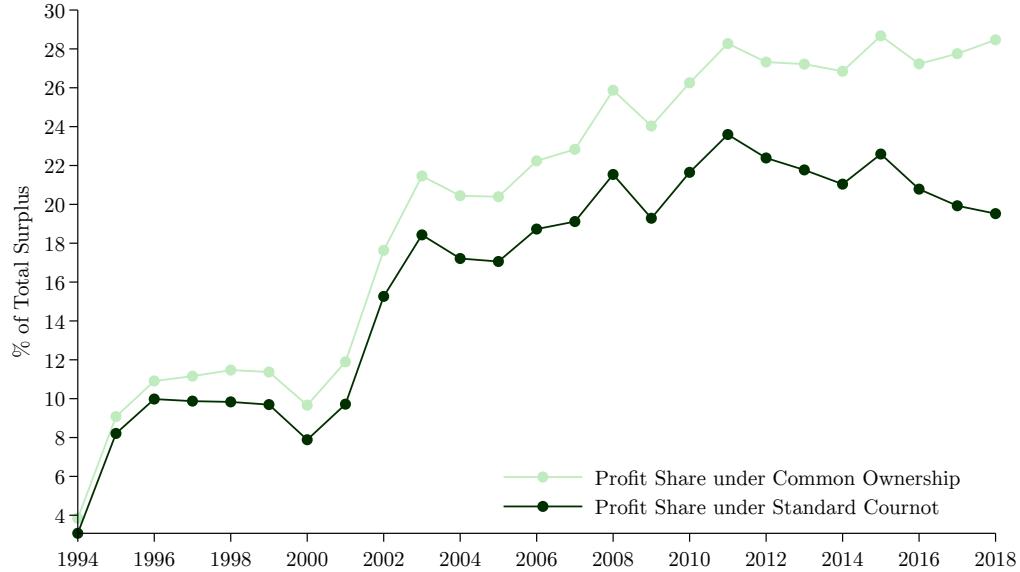


FIGURE NOTES: The figure plots the profit share net of fixed costs under standard Cournot (dark green line) and Cournot with common ownership (light green line) between 1994 and 2018.

FIGURE 12: DEADWEIGHT LOSS NET OF FIXED COSTS

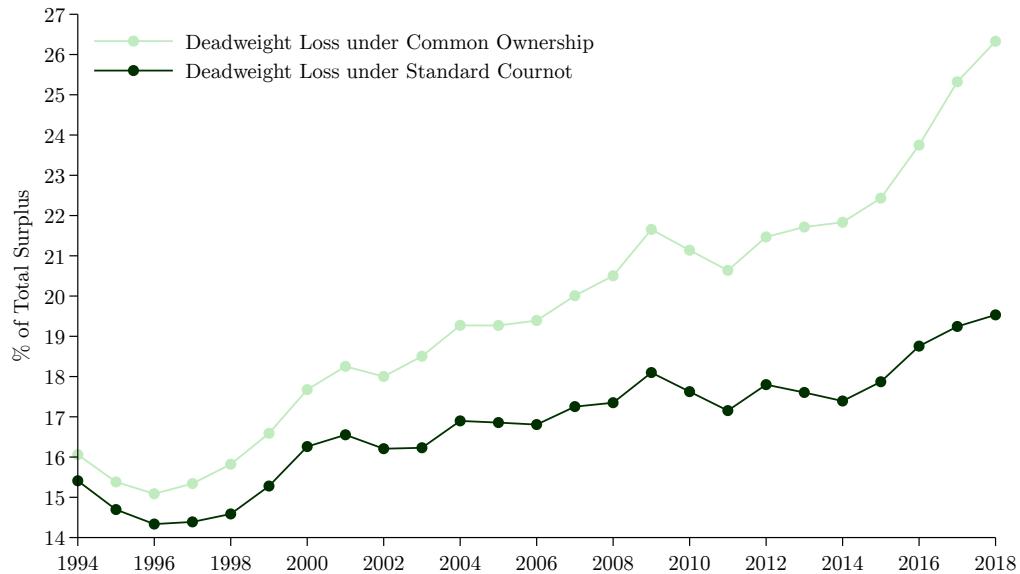


FIGURE NOTES: The figure plots the estimated deadweight loss (DWL) of oligopoly and of oligopoly and common ownership, between 1994 and 2018. The dark green line is the DWL of oligopoly, the % difference in total surplus between the Cournot equilibrium and the Perfect Competition scenario. The light green line is the % difference between the Cournot Common Ownership equilibrium and the Perfect Competition scenario. These surplus measures are net of fixed costs.

FIGURE 13: PROFIT SHARE OF TOTAL SURPLUS NET OF FIXED COSTS

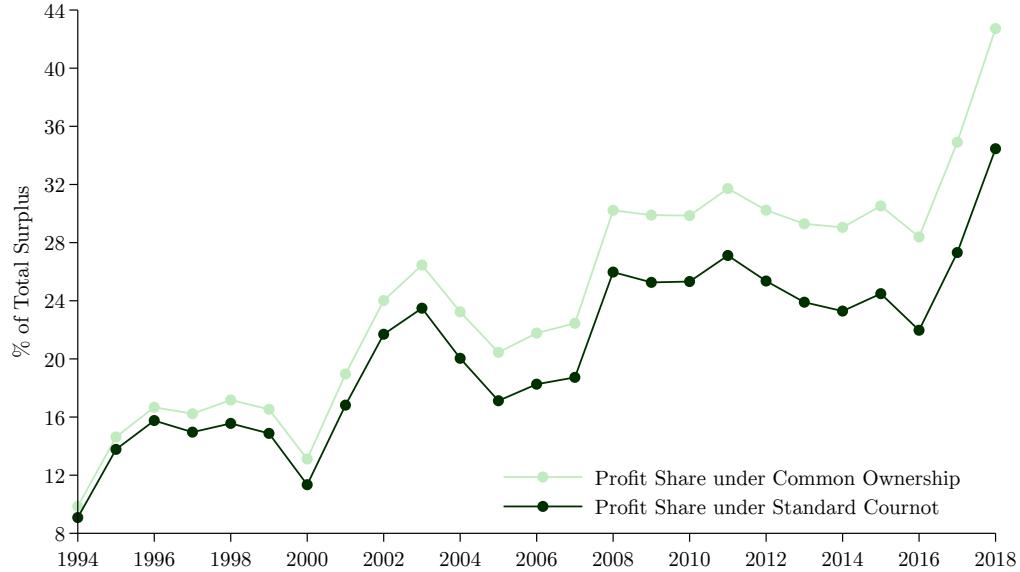


FIGURE NOTES: The figure plots the profit share net of fixed costs under standard Cournot (dark green line) and Cournot with common ownership (light green line) between 1994 and 2018.

FIGURE 14: DEADWEIGHT LOSS NET OF FIXED COSTS

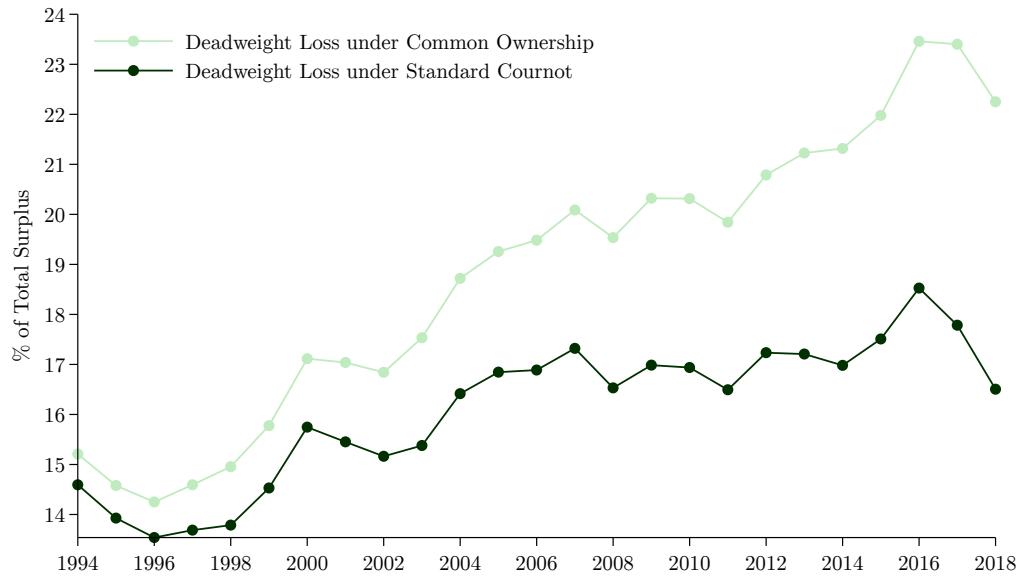


FIGURE NOTES: The figure plots the estimated deadweight loss (DWL) of oligopoly and of oligopoly and common ownership, between 1994 and 2018. The dark green line is the DWL of oligopoly, the % difference in total surplus between the Cournot equilibrium and the Perfect Competition scenario. The light green line is the % difference between the Cournot Common Ownership equilibrium and the Perfect Competition scenario. These surplus measures are net of fixed costs.

## D Calibration

### D.1 Mapping to Data and Identification

Table 4 documents how the variables in our model correspond to data, including the sources of these data. We follow De Loecker et al. (2020, henceforth DEU) in excluding firms with negative revenues or costs of goods sold, or negative gross margin (revenues less COGS). Furthermore, we follow their computation of the user cost of capital, which is equal to the federal funds rate (FEDFUNDS from FRED), minus capital goods inflation (PIRIC from FRED), plus a combined depreciation rate and risk premium set at 12%.

### D.2 Calibrating the Cost Function

The firms' variable cost function is:

$$h_i = c_i q_i + \frac{\delta_i}{2} q_i^2 \quad (\text{D.1})$$

Calibrating the cost function means calibrating the slopes  $\delta_i$ . Firms produce using the following quasi-Cobb-Douglas production function:

$$q_i = k_i^\theta \cdot \ell(h_i) \quad (\text{D.2})$$

where  $k_i$  is the capital input. Following DEU who also use Compustat data, we measure capital in Compustat as Property, Plant and Equipment). We use their estimates to calibrate  $\theta = 0.15$ .

Then it must be the case that  $\ell(\cdot)$  respects:

$$h_i = \ell^{-1}\left(\frac{q_i}{k_i^\theta}\right) \stackrel{\text{def}}{=} \tilde{c}_i \left(\frac{q_i}{k_i^\theta}\right) + \frac{\tilde{\delta}}{2} \left(\frac{q_i}{k_i^\theta}\right)^2 \quad (\text{D.3})$$

where, by definition:

$$c_i = \frac{\tilde{c}_i}{k_i^\theta} \quad \text{and} \quad \delta_i = \frac{\tilde{\delta}}{k_i^{2\theta}} \quad (\text{D.4})$$

We assume that  $\tilde{\delta}$  is constant across firms and over time. We thereby reduce the dimensionality of the cost parameter vector to one ( $\tilde{\delta}$ ). The markup  $\mu_i$  of firm  $i$  is equal to:

$$\mu_i \stackrel{\text{def}}{=} \frac{p_i}{\text{MC}_i} = \frac{(2 + \delta_i) \cdot p_i q_i}{2 \cdot h_i + \delta_i \cdot p_i q_i} \quad (\text{D.5})$$

We can rewrite equation (D.5) as a function of  $\tilde{\delta}$  and observables:

$$\mu_i = \frac{(2k_i^{2\theta} + \tilde{\delta}) \cdot p_i q_i}{2k_i^{2\theta} \cdot h_i + \tilde{\delta} \cdot p_i q_i} \quad (\text{D.6})$$

where  $(p_i q_i, h_i, k_i)$  are all obtained from Compustat.

TABLE 4: VARIABLE DEFINITIONS AND MAPPING TO DATA

**Panel A: Observed Variables**

Notation	Concept	Measurement
$p_i q_i$	Revenues	Revenues (source: <i>Compustat</i> )
$h_i$	Total Variable Costs	Costs of Goods Sold (source: <i>Compustat</i> )
$f_i$	Fixed Costs Fixed Costs (alternative)	$\text{SGA}_i + \text{Property Plant \& Equipment}_i \times \text{User Cost of Capital}$ $(\text{SGA}_i - \text{R\&D}_i) \times 0.7 + (\text{Property Plant \& Equipment}_i + \text{Intangible Capital}_i) \times \text{UCC}$ (source: <i>Compustat, Federal Reserve Economic Data</i> )
$\mathbf{a}'_i \mathbf{a}_j$	Product Cosine Similarity	Word cosine similarity in 10-K product description (source: <i>Hoberg and Phillips, 2016</i> )
$\mathbf{s}'_i \mathbf{s}_j$	Ownership	Equity ownership shares of publicly-listed companies (source: <i>SEC 13(f) filings</i> )

**Panel B: Identified Variables**

Notation	Derived Variable	Computation/Identification
$q_i$	Output	$\pi = \text{diag}(\mathbf{q}) (\mathbf{I} + \frac{1}{2}\boldsymbol{\Delta} + \mathbf{K} \circ \boldsymbol{\Sigma}) \mathbf{q}$
$c_i$	Marginal Cost Intercept	$c_i = h_i/q_i - \frac{1}{2}\delta_i q_i$
$\mathbf{b}$	Demand Intercept	$\mathbf{b} = (2\mathbf{I} + \boldsymbol{\Delta} + \boldsymbol{\Sigma} + \mathbf{K} \circ \boldsymbol{\Sigma}) \mathbf{q} + \mathbf{c}$

To calibrate  $\tilde{\delta}$ , we target the markup estimates of DEU. Specifically, we calibrate  $\tilde{\delta}$  so that the model-inferred average markup matches exactly that their estimates:

$$\tilde{\delta} : \quad \mathbb{E} \left[ \frac{(2k_i^{2\theta} + \tilde{\delta}) \cdot p_i q_i}{2k_i^{2\theta} \cdot h_i + \tilde{\delta} \cdot p_i q_i} \right] = \mathbb{E}(\mu_i^{\text{DEU}}) \quad (\text{D.7})$$

Following DEU, we weight markups by revenues in order to compute this average.

### D.3 Non-Targeted Moments (Model Fit)

For the model to realistically capture the deadweight losses from oligopoly it should generate meaningful time-series and cross-sectional variation in markups. Moreover, we would expect the model-implied markups to correlate with existing econometric estimates.

We examine non-targeted moments of the distribution of markups to evaluate the empirical performance of the model. The first non-targeted moment is the time-series correlation between the revenue-weighted average markup ( $\mu_i$ ) from our model and the corresponding estimate by DEU. Figure 15 plots the two series. The dark green line is the average markup based on our model. The light green line is the series computed by DEU.

Pellegrino (2019) calibrates  $\tilde{\delta}$  by targeting the average revenue-weighted markup over 1957–1982 and shows that the implied average markups closely tracks DEU after 1982 (i.e., outside the calibration window). In our model, we cannot compute markups without an estimate of  $\Sigma$  and  $\mathbf{K}$ . As a result, our markups series only starts in 1994. Nonetheless, the markup implied by our model of oligopolistic competition under common ownership corresponds quite closely to the time trend of the average markup of DEU after 1994.

Next, we examine how much cross-sectional variation in markups the model is able to generate. One major limitation of current general equilibrium models with market power is that the cross-sectional variation in markups that they can endogenously generate is nowhere close to that estimated by DEU.

In Figure 16, we plot the cross-section of markups obtained from the model against DEU’s estimates. Both axes use a log scale. We include data from 1997, 2007 and 2017. As in DEU, we weight observations by revenue (weights are represented by circle sizes). On the one hand, it is fairly evident from the graph that there is more variation in the markups estimated by DEU than in the model-based estimates: the range is wider and the fitted regression slope (the dotted black line) is larger than one. On the other hand, we find that our model-based estimates capture a remarkable 77% of the cross-sectional variation in markups (as measured by the  $R^2$  of a regression where the slope is constrained to one).<sup>15</sup>

Another important question from the point of view of model fit is how well our model-based estimates of the cross-price elasticity of demand correlate with the corresponding microeconometric

---

<sup>15</sup>If we do not constrain the coefficient to one, the  $R^2$  increases to 83%.

FIGURE 15: REVENUE-WEIGHTED AVERAGE MARKUP

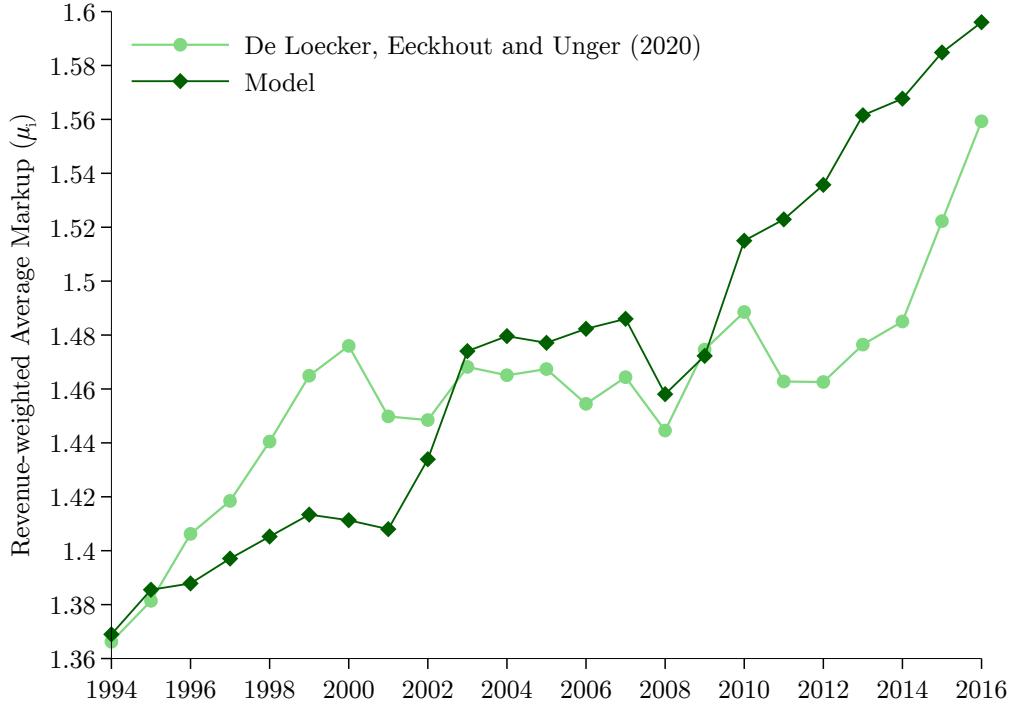


FIGURE NOTES: The figure plots the time series of average markups estimated by our model (dark green line) and by DEU (light green line).

estimates that were used to calibrate the parameter  $\alpha$ . Our strategy for calibrating  $\alpha$  is to target microeconometric estimates from the IO literature. For a number of firm pairs we obtain direct estimates of the cross-price demand elasticity from empirical IO studies. These estimates of the cross-price demand elasticity are then manually matched to the corresponding firm pair in Compustat. To calibrate  $\alpha$ , we can rewrite equation (2.18) as:

$$\left| \frac{\partial \log p_i}{\partial \log q_j} \right| = \alpha \cdot \mathbf{a}_i' \mathbf{a}_j \frac{q_j}{p_i} \quad \forall i \neq j \quad (\text{D.8})$$

Finally, for each firm pair, we can obtain an estimate of  $\alpha$  by rearranging equation (D.8):

$$\hat{\alpha}_{ij} = \left| \frac{\partial \log p_i}{\partial \log q_j} \right| / \left( \mathbf{a}_i' \mathbf{a}_j \frac{q_i}{p_i} \right) \quad (\text{D.9})$$

Equation (D.9) can be rearranged as:

$$\log \left| \frac{\partial \log p_i}{\partial \log q_j} \right| \approx \log \alpha + \log \left( \mathbf{a}_i' \mathbf{a}_j \frac{q_j}{p_i} \right) \quad (\text{D.10})$$

where we use the symbol  $\approx$  to denote the fact that measurement error contaminates what should

FIGURE 16: CALIBRATED MARKUPS VS. DEU

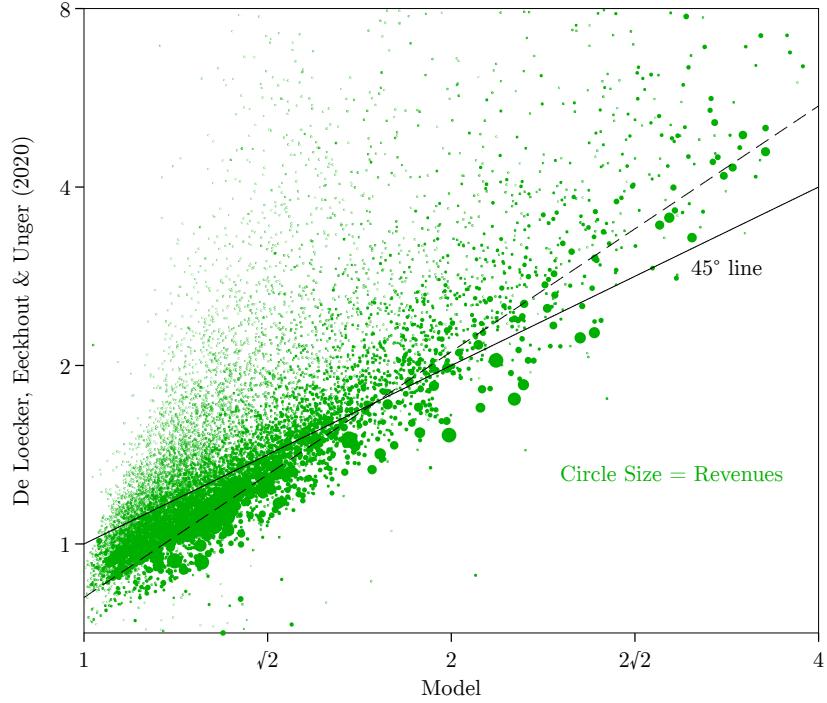


FIGURE NOTES: The figure plots the cross-section of markups obtained from the model against DEU's estimates with the size of the circle representing each firm's revenues.

be a linear-in-logs relationship.

By calibrating  $\alpha$ , we are only able to choose the intercept of this linear relationship, not the slope nor the correlation. We use the (untargeted) slope and the goodness-of-fit of equation (D.10) to evaluate the model fit.

In Table 5, we report the relationship between the microeconometric estimates (the left side of equation D.10) and the model-based estimates that use the calibrated value of  $\alpha$ .

TABLE 5: MODEL FIT - CROSS-PRICE DEMAND ELASTICITIES

Statistic	Data	Model	Targeted
Mean (in logs)	-2.81	-2.83	Yes
Standard Deviation (in logs)	0.522	0.326	No
Correlation w/Data (in logs)	1.000	0.584	No
Number of Observations	32	32	