A Tale of Two Networks: Common Ownership and Product Market Rivalry*

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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 with a hedonic demand system in which firms compete in a network game of oligopoly. Firms are connected through two large networks: the first reflects ownership overlap, the second product market rivalry. In our model, common ownership of competing firms induces unilateral incentives to soften 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 U.S. public corporations 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 the ratio of deadweight loss to total surplus, has increased nearly tenfold (from 0.3% to over 4%) between 1994 and 2018. Under alternative governance assumptions the deadweight loss in 2018 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

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1 Introduction

The U.S. economy has experienced two significant trends in concentration over the last three decades. First, across a broad range of industries revenue and employment concentration have increased considerably (Grullon et al., 2019; Pellegrino, 2019). Second, the ownership of corporate equity has become concentrated in the hands of a few large institutional investors (Ben-David et al., 2020). This latter trend is also known as the rise of common ownership (Azar, 2012; Gilje et al., 2020; Backus et al., 2021b). This paper studies the increasing concentration of the overlapping networks of product market competition and firm ownership and shows that the resulting welfare costs and distributional consequences are significant.

Under common ownership, large investors own shares in several competing firms. Its tremendous increase has raised concerns among 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 aggressive market decisions on their competitors' profits. This may induce firms to produce lower quantities or to charge higher prices, ultimately leading to deadweight and consumer surplus losses. This mechanism of harm of common ownership is supported by a theoretical literature, starting with Rubinstein and Yaari (1983) and Rotemberg (1984), and several empirical contributions (Azar et al., 2018; Antón et al., 2020; Xie and Gerakos, 2020; Shekita, 2021) that study oligopolistic behavior in the presence of common ownership. In response, antitrust authorities around the world including the Department of Justice, the Federal Trade Commission, and the European Commission have acknowledged concerns about the anticompetitive effects of common ownership.[1]

In this paper, we analyze the economy-wide 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 institutional investor holdings (Backus et al., 2021b) covering the universe of U.S. publicly listed corporations from 1994 to 2018. We perform counterfactual calculations to evaluate how the efficiency and the distributional impact of common ownership have evolved over this period, finding large negative

[1] 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).

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 make strategic decisions 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 economy-wide 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?[2] 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.

We visualize the two networks of product similarity and common ownership in which firms are embedded. 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. 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 model estimation 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 oligopoly (as measured by the loss in total surplus due to firms competing à la Cournot as

[2]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). We consider neither coordinated anticompetitive effects of common ownership which may result from explicit or tacit collusion between firms or owners as documented by Shekita (2021) nor beneficial effects such as the internalization of innovation spillovers (Antón et al., 2018) or financial diversification. Thus, our analysis focuses exclusively on the welfare *costs* of *unilateral product market* effects of common ownership.

opposed to competing as under perfect competition) amounts to about 11.5% of total surplus. Common ownership leads to an additional deadweight loss of 4% of total surplus (as measured by the additional loss in total surplus due to firms internalizing overlap in ownership with their competitors when competing à la Cournot). 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 and almost 20% in 2018.

We further explore how alternative assumptions about corporate governance modify these results. Rather than investors influencing firm decisions exactly in proportion to their ownership stakes, larger investors may exert influence that exceeds the size of their stake. Under such an alternative "superproportional influence" assumption, common ownership has essentially identical effects on deadweight loss, corporate profits, and consumer surplus. However, 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 still 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.

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 and substitution patterns 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., 2021a,b). Whereas those papers focus on input-output networks we study networks of ownership and product market rivalry. As a result, our work shares some similarities with Bloom et al. (2013) who study R&D spillovers across product market and technological networks. 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; Pellegrino, 2019; Syverson, 2019) and on the quantification of market power in the macroeconomy (De Loecker et al., 2021; Olmstead-Rumsey, 2021).[3] By incorporating hedonic demand and data on product market similarity and ownership we characterize a competitive environment in which firms differ not only by their productivity, but also by their product characteristics, their ownership, and the connections between the two.

Finally, our paper is related to the burgeoning literature on common ownership. 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). In contrast to much of the literature (Matvos and Ostrovsky, 2008; 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; Backus et al., 2021a; Saidi and Streitz, 2021), we do not analyze whether or not common ownership affects the competitive conduct of firms in a specific industry. Instead, our paper considers a different research question: What are the economy-wide welfare and distributional consequences of increased product market power due to common ownership? The tractability and flexibility of our framework allow us to test the robustness of our results to different assumptions about the mode of firm governance.

Our analysis shows that, at the aggregate level, common ownership effects will generate significant distortions and reallocation of surplus—even under conservative assumptions about corporate governance. Because current empirical evidence on common ownership conduct focuses on a limited set of industries with concerns about external validity and generalizability, our results suggest that it is important to evaluate common ownership effects across a much broader set of industries.

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 baseline model that only considers proportional ownership influence (i.e., investors exerting control in proportion to their ownership shares). After characterizing the equilibrium of this model economy and outlining a series of counterfactuals, we extend the model to consider alternative governance assumptions.

[3] 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 seminal contributions to this literature include Kamerschen (1966), Bergson (1973), and Cowling and Mueller (1978). Berger et al. (2019) quantify economy-wide welfare losses from labor market power.

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 $i \in \{1, 2, \ldots, n\}$ that produce differentiated products. Consumers have hedonic demand (Lancaster, 1966; Rosen, 1974) and value each product as a bundle of characteristics.[4] The number of characteristics is $m + n$.

Each product has two types of characteristics: m common characteristics indexed by $\iota \in \{1, 2, \ldots, m\}$ 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 $a_{\iota i}$ is the number of units of common characteristic ι 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:

$$\mathbf{a}_i \;=\; \begin{bmatrix} a_{1i} & a_{2i} & \ldots & a_{mi} \end{bmatrix}' \tag{2.1}$$

$$\text{such that} \qquad \sum_{j=1}^{m} a_{ji}^2 = 1 \quad \forall\, i \in \{1, 2, \ldots, n\} \tag{2.2}$$

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 $\mathbf{A}$:

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

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

$$\mathbf{q} \;=\; \begin{bmatrix} q_1 & q_2 & \cdots & q_n \end{bmatrix}' \tag{2.4}$$

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

$$x_j \;=\; \sum_i a_{ji} q_i \tag{2.5}$$

[4] More recently, Pellegrino (2019) and Eeckhout and Veldkamp (2021) use similar hedonic-linear demand systems that model goods as bundles of attributes to study the welfare consequences of market power.

The matrix $\mathbf{A}$ converts units of goods purchased $\mathbf{q}$ into units of common characteristics:

$$\mathbf{x} \;=\; \mathbf{A}\mathbf{q} \tag{2.6}$$

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 of worked H. It is given by

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

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

$$H \;=\; \sum_i h_i. \tag{2.8}$$

Labor is the numéraire of this economy: the price of one unit of labor is normalized to 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

$$q_i \;=\; k_i^{\theta}\cdot\ell\left(h_i\right) \tag{2.9}$$

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

$$h_i \;=\; c_i q_i \;+\; \frac{\delta_i}{2}\,q_i^2 \tag{2.10}$$

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

$$\mathrm{MC}_i \;=\; c_i + \delta_i q_i; \qquad \mathrm{AVC}_i \;=\; c_i + \frac{\delta_i}{2} q_i. \tag{2.11}$$

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

$$\mathrm{TC}_i \;=\; f_i + c_i q_i + \frac{\delta_i}{2} q_i^2 \tag{2.12}$$

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

$$H + \Pi \;=\; \sum_{i=1}^{n} p_i q_i. \tag{2.13}$$

2.2 Consumption Choices, Labor Supply, and Product Demand

Define

$$\mathbf{b} \;\overset{\text{def}}{=}\; \alpha\, \mathbf{A}'\mathbf{b}^x + (1-\alpha)\, \mathbf{b}^q \tag{2.14}$$

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

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

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:

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

$\mathbf{a}_i'\mathbf{a}_j$ 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 which 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 following matrix

$$\mathbf{\Sigma} \;\overset{\text{def}}{=}\; \alpha\left(\mathbf{A}'\mathbf{A} - \mathbf{I}\right). \tag{2.17}$$

Thus, the demand and inverse demand functions are given by

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

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

The quantity sold by each firm affects the price of the output sold by every other firm in the economy unless the matrix $\mathbf{\Sigma}$ 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 this derivative is 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 profits π_i of firm i are therefore given by

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

2.3 Advantages of GHL

2.3.1 Complementarities

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

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

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:

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

The important insight is that the cross-price elasticity of demand depends on the inverted matrix $(\mathbf{I} + \mathbf{\Sigma})^{-1}$, not on $\mathbf{\Sigma}$ itself. If, as in our case, $\mathbf{\Sigma}$ is not symmetric, the off-diagonal elements of $-(\mathbf{I} + \mathbf{\Sigma})^{-1}$ 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 complementarity arises from the fact that, in our model, "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 Price-Cost Passthrough and Markups

GHL differs from the perhaps more standard CES demand setup 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

FIGURE 1: DEMAND SYSTEM COMPARISON

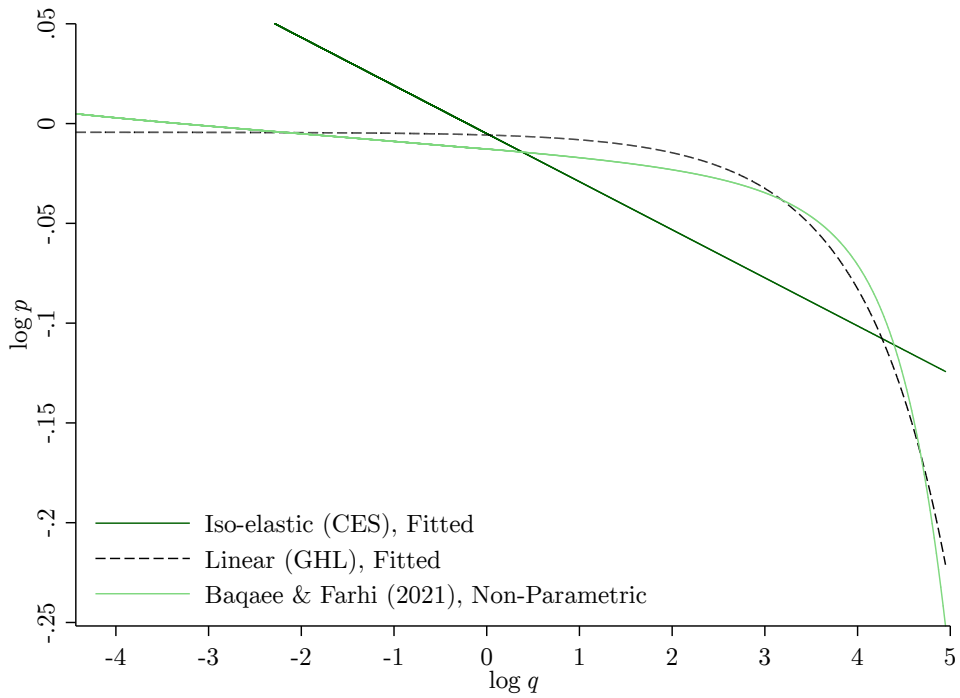


FIGURE NOTES: The figure shows a log-log plot of the demand curve estimated non-parametrically by Baqaee and Farhi (2020a) (solid light green line), against a linear (GHL) fit (dotted black line) and against an isoelastic (CES) fit (solid dark green line). Note that an isoelastic curve becomes a straight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

actual demand. 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 Baqaee and Farhi (2020a) respectively.[5] Whereas the GHL demand curve closely matches the non-parametric estimates of Baqaee 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 share in each company i

$$V_z \overset{\text{def}}{=} \sum_{i=1}^{n} s_{iz}\, \pi_j \qquad \sum_{z=1}^{Z} s_{iz} = 1 \tag{2.22}$$

[5] Baqaee 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.

where s_{jz} is the percentage of shares of company j owned by investor z.[6] Following Rotemberg (1984), we assume that the manager of firm i maximizes ϕ_i, an average of firm i's investors' value functions, weighted by the investors' ownership shares in all firms in the economy:

$$\phi_i \overset{\text{def}}{=} \sum_{z=1}^{Z} s_{iz} V_z = \sum_{z=1}^{Z} s_{iz} \sum_{j=1}^{n} s_{jz} \pi_j = \sum_{j=1}^{n} \pi_j \sum_{z=1}^{Z} s_{iz} s_{jz} \tag{2.23}$$

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

$$\mathbf{s}_i \overset{\text{def}}{=} \begin{bmatrix} s_{i1} & s_{i2} & \dots & s_{iZ} \end{bmatrix}' \tag{2.24}$$

Define the common ownership weights κ_{ij} as

$$\kappa_{ij} \overset{\text{def}}{=} \frac{\mathbf{s}_i' \mathbf{s}_j}{\mathbf{s}_i' \mathbf{s}_i}. \tag{2.25}$$

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

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

Our notation directly follows Backus et al. (2021b) and Antón et al. (2020).[7] We interpret κ_{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 ϕ_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). 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

[6] We assume that ownership allocations are exogenous as is standard in the literature. We do not analyze how financial market trading shapes the ownership structure of competing firms as in Piccolo and Schneemeier (2020).

[7] López and Vives (2019a) and Azar and Vives (2021a) use the same formulation but denote κ_{ij} by λ_{ij}.

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.[8] 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 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 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

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

with ε arbitrarily small. Managers have increasing utility over and spend all of their income on a "luxury" good (e.g., yachts or private jets)[9] indexed by 0, which is produced competitively with a linear technology using only labor. Let q_{i0} denote the quantity of the 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 condition for the production of good 0

$$\sum_{i=1}^{I} q_{i0} = h_0 \tag{2.28}$$

and the price p_0 is one by construction. The assumption of ε being arbitrarily small implies that

[8] Oligopoly deadweight losses, markups, and misallocations 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.

[9] 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.

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 behavior 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 $\mathbf{\Sigma}$ (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

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

$$\text{where} \qquad \mathbf{\Delta} \overset{\text{def}}{=} \begin{bmatrix} \delta_1 & 0 & \cdots & 0 \\ 0 & \delta_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \delta_n \end{bmatrix} \tag{2.30}$$

The diagonal matrix $\mathbf{\Delta}$, which contains the slopes of the marginal cost functions, captures economies of scale. $\mathbf{\Sigma}$ 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 κ_{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:

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

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 game in which the manager of each firm i maximizes the objective function ϕ_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 ϕ_i firms maximize just their own profits π_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).[10] For example, the potential function $\Xi(\mathbf{q})$ can be intuitively thought of 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.

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

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 κ_{ij} in $\mathbf{K}$ are equal to 0 for $i \neq j$ and equal to 1 for $i = j$:

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

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

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

[10] 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.

The least competitive allocation is *Monopoly*. It represents a situation in which a single investment fund which 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 $\Pi(\mathbf{q})$:

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

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., $\kappa_{ij} \to 1$).

3 Data

3.1 Mapping to Data

Table 1 documents how the variables in our model correspond to data, including the sources of these data. Revenues, variables cost, and fixed costs are measured using data from Compustat. 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%.

To construct the networks of product market rivalry and ownership we use data from 10-K product descriptions and 13(f) filings. We discuss the construction of these networks in detail below.

3.2 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 *business 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 $\mathbf{o}_i$.

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

TABLE 1: VARIABLE DEFINITIONS AND MAPPING TO DATA

Panel A: Observed Variables

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

Panel B: Identified Variables

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

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

$$\mathbf{a}_i = \frac{\mathbf{o}_i}{\|\mathbf{o}_i\|}. \tag{3.2}$$

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

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

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.[11]

3.3 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 under management (AUM) in excess of $100 million are required to report their holdings of U.S. securities, including those of all U.S. 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 $\mathbf{K}$ using a statistical correction to account for the presence of unobserved investors, as detailed in Appendix A. Constructing detailed ownership

[11] 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.

data, even for 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. Without such a correction to account for the presence of unobserved investors we would obtain a thick right tail of implausibly large κ_{ij}.

3.4 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 parameter α and the diagonal matrix $\mathbf{\Delta}$. 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 $\mathbf{b}$.

First, we note that the cost function must take the form:

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

where, by definition:

$$c_i \; = \; \frac{\tilde{c}_i}{k_i^\theta} \qquad \text{and} \qquad \delta_i \; = \; \frac{\tilde{\delta}}{k_i^{2\theta}} \tag{3.5}$$

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

We take the calibrated parameters for α 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 C 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 the quantities $\mathbf{q}$, and the matrices $(\mathbf{\Delta}, \mathbf{\Sigma}, \mathbf{K})$, which are already measured or calibrated:

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

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:

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

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 two networks that characterize our oligopoly game: that of product similarities and that of common ownership. We first visualize the network structure of HP's product similarity dataset. To do so, we reduce its dimensionality from 61,146 (the number of words in the HP's vocabulary) to two, using the algorithm of Fruchterman and Reingold (1991, henceforth FR), which is widely used in network science to visualize weighted networks.[12]

Every publicly traded firm in 2004 is a dot in 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 using 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 increases to 0.0174 in 2018. In contrast, the average value of κ_{ij} is equal to 0.0021 in 1994 but rises almost sevenfold to 0.0146 in 2018.

[12] 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

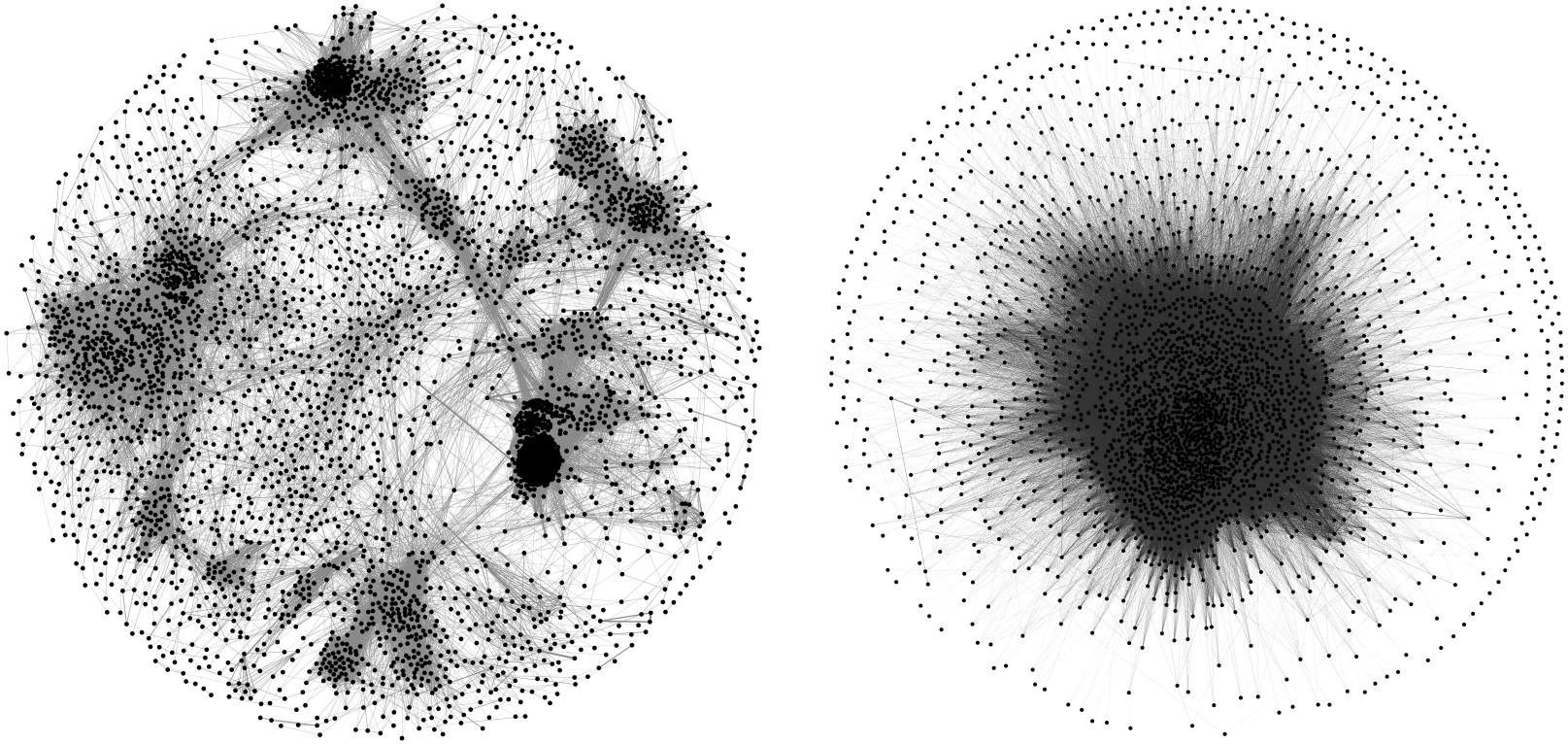


FIGURE NOTES: The diagrams are two-dimensional representations of the network of product similarities (left panel) computed by Hoberg and Phillips (2016) and of the network of ownership shares (right panel). Both networks are used in the estimation of the model presented in Section 2. The data cover 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).

FIGURE 3: PRODUCT SIMILARITY AND PROFIT WEIGHTS (2018)

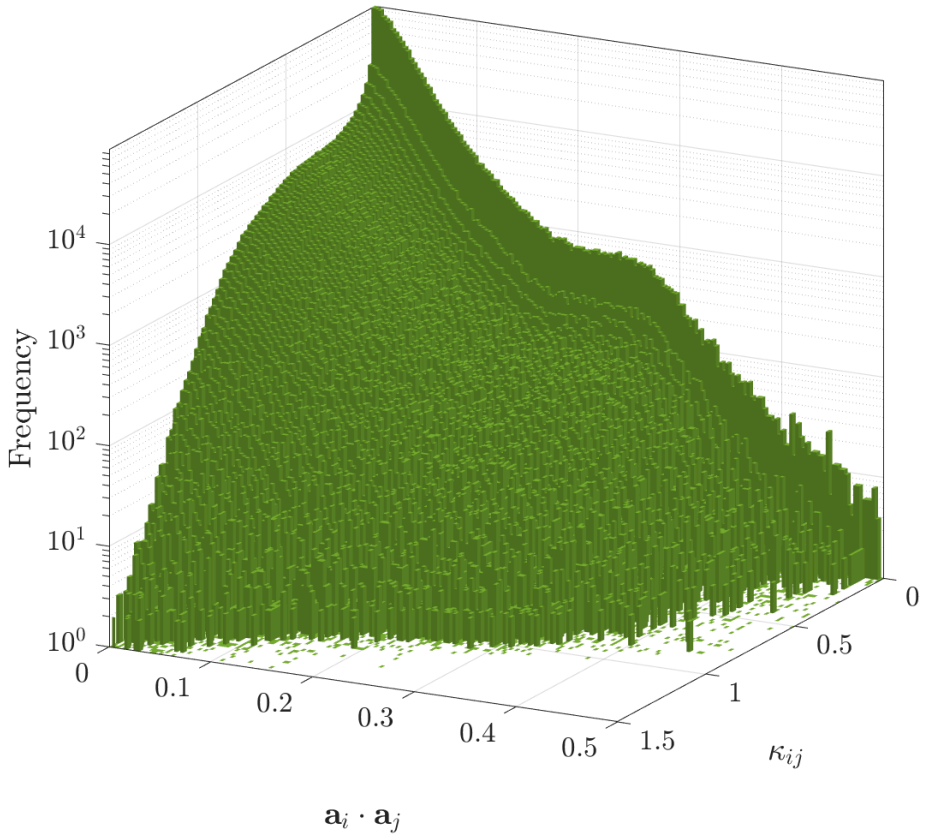


FIGURE NOTES: The figure above is a histogram representing of the joint distribution of product similarity $\mathbf{a}_i \cdot \mathbf{a}_j$ and profit weights κ_{ij} for all firm ij pairs in 2018.

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 $\mathbf{\Sigma}$ and common ownership $\mathbf{K}$ because this relationship governs the magnitude of the welfare cost of common ownership. As can be seen from equation (2.31) it is the Hadamard product of $\mathbf{K}$ and $\mathbf{\Sigma}$ 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 plots the histogram of the joint distribution of the product similarity $\mathbf{a}_i \cdot \mathbf{a}_j$ and the common ownership weight κ_{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 κ_{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 κ_{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 κ_{ij} has values greater than 1. Such values of κ exceeding 1 lead to owners placing more weight on the profits of competitor 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 κ_{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 2 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 3 in the appendix reports the same estimates for 1994, the first year of our sample. Additionally, Table 4 in the appendix reports the estimates when all κ_{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.[13]

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

[13] 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 2: WELFARE ESTIMATES (2018)

	Scenario	*Common Ownership*	*Cournot-Nash*	*Perfect Competition*	*Monopoly*
		(1)	(2)	(3)	(4)
Welfare Statistic	**Variable**	$\mathbf{q}^{\Xi}$	$\mathbf{q}^{\Psi}$	$\mathbf{q}^{W}$	$\mathbf{q}^{\Pi}$
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)	$\mathrm{CS}(\mathbf{q})$	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	$\frac{\mathrm{CS}(\mathbf{q})}{W(\mathbf{q})}$	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 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 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.

In sum, the result of our comparative static analysis is that the combination of oligopoly and common ownership of U.S. public firms has considerable effects on allocative efficiency, firm profits, and consumer welfare.

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

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

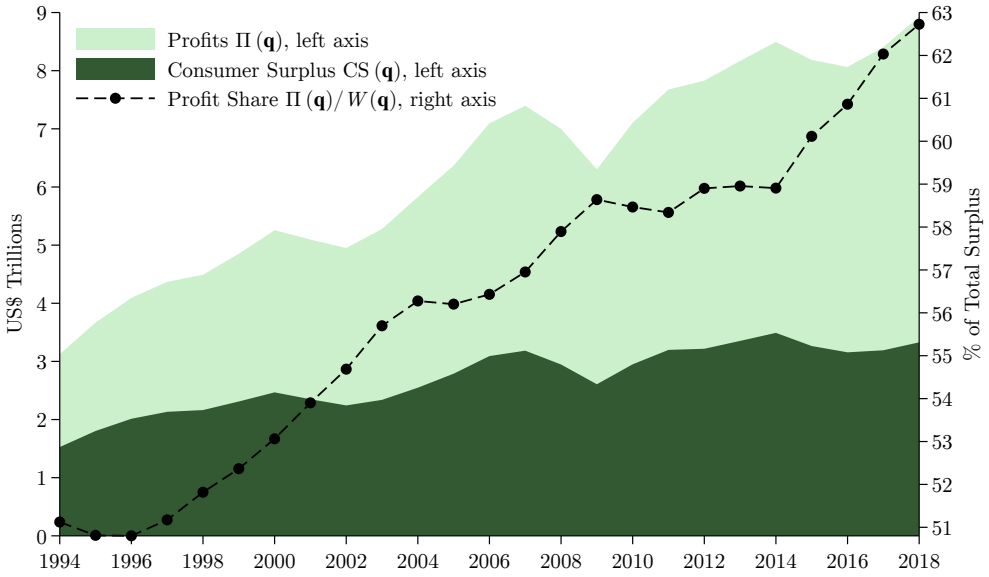


FIGURE NOTES: The figure plots the evolution of aggregate (economic) profits $\Pi(\mathbf{q})$, aggregate consumer surplus $CS(\mathbf{q})$, and total surplus $W(\mathbf{q})$, as defined in the model in Section 2. Profits as a percentage of total surplus ($\Pi(\mathbf{q})/W(\mathbf{q})$, black dotted 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.

among publicly listed U.S. companies for the period from 1994 to 2018.[14]

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. The combined area represents (nominal) total surplus W. On the right axis we also plot profits as a share of total surplus Π/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

[14] 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 5: PROFIT SHARE OF TOTAL SURPLUS

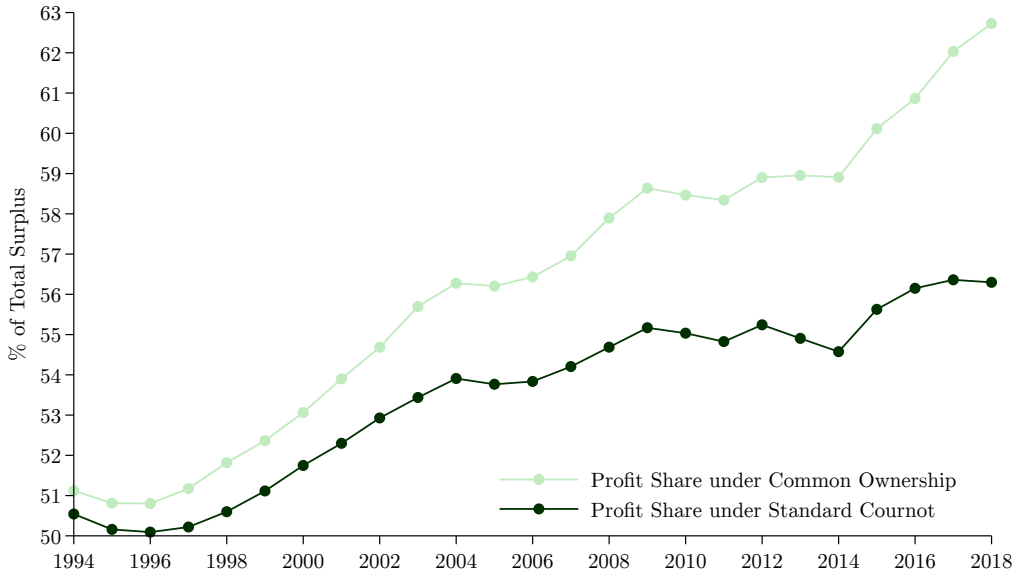


FIGURE NOTES: The figure plots the profit share under standard Cournot (dark green line) and Cournot with common ownership (light green line) between 1994 and 2018.

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 Cournot equilibrium $\mathbf{q}^{\Psi}$ and from the CCO 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,

FIGURE 6: DEADWEIGHT LOSS

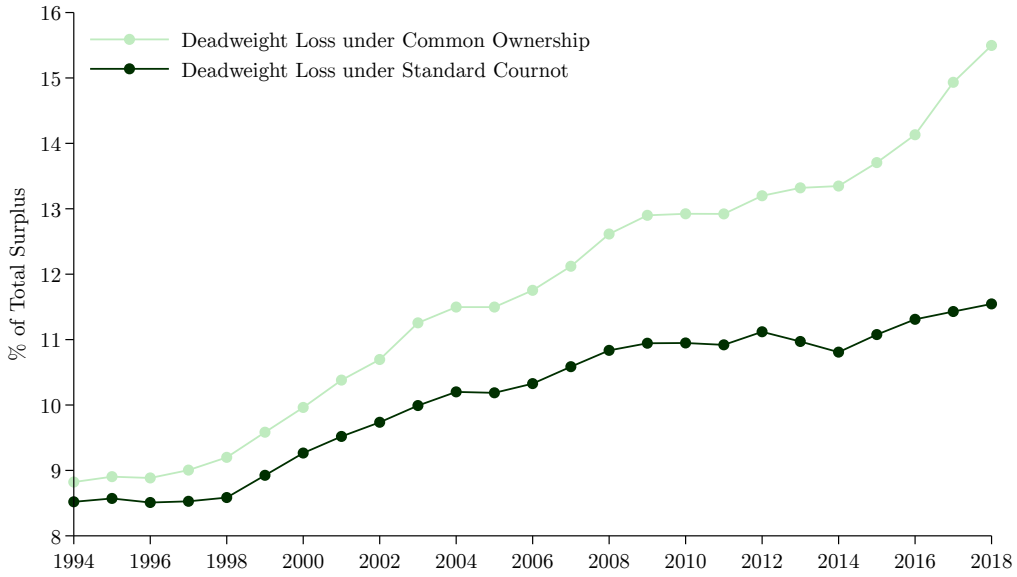


FIGURE NOTES: The figure plots the estimated deadweight loss (DWL) of oligopoly and of oligopoly and common ownership, between 1994 and 2018. The dark green line is the DWL of oligopoly, the % difference in total surplus between the Cournot equilibrium and the Perfect Competition scenario. The light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

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%).

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. For each of these alternative governance models, we then perform welfare calculations (as we did for the baseline model). This allows us to investigate the sensitivity of our results to these governance assumptions.

5.1.1 Superproportional Influence of Large Investors

The governance model previously presented assumes that each firm i maximizes the profit shares of its investors, weighting them in proportion to the stake they own, when setting q_i. However, there are good reasons to believe that larger investors exert influence that exceeds the size of their stake. That is to say, proportional influence as assumed by Rotemberg (1984) may over- or understate the importance of large investors for strategic firm decisions. One reason this might be the case is that corporate voting is more akin to majoritarian rather than proportional representation (Azar and Vives, 2021b).

Suppose that firm i weights the profits of investor z by $s_{iz} \cdot \gamma_{iz}$ (as opposed to s_{iz}). Here γ_{iz} is an investor "influence" weight that can increase or decrease the weight assigned to a particular investor depending on how large the investor's stake in company i is. We can then define the following influence-adjusted common ownership weights. $\tilde{\kappa}_{ij}$ by

$$\tilde{\kappa}_{ij} \overset{\text{def}}{=} \frac{\sum_{z=1}^{Z} s_{iz}\gamma_{iz}s_{jz}}{\sum_{z=1}^{Z} s_{iz}\gamma_{iz}s_{jz}} \tag{5.1}$$

The analysis of Gilje et al. (2020) suggests that these influence weights are concave in the ownership shares of investors. Consistent with their approach (and with that of Backus et al. 2021b), we approximate this influence function using a square root (i.e., $\gamma_{iz} \overset{\text{def}}{=} \sqrt{s_{iz}}$).

5.1.2 Blockholder Thresholds

An alternative way to model the fact that large investors exercise a disproportional level of control over a corporation is to introduce "blockholders." These are investors that are presumed to actively exercise control on some company i if their stake in i exceeds a certain threshold.

The literature typically defines a blockholder as a shareholder holding 5% or more of a company's stock, due the fact that this level triggers additional SEC disclosure requirements (Edmans and Holderness, 2017). Blockholders have been shown to play an important role in ensuring that 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").

FIGURE 7: COMMON OWNERSHIP: DEADWEIGHT LOSS AND DISTRIBUTIONAL EFFECTS

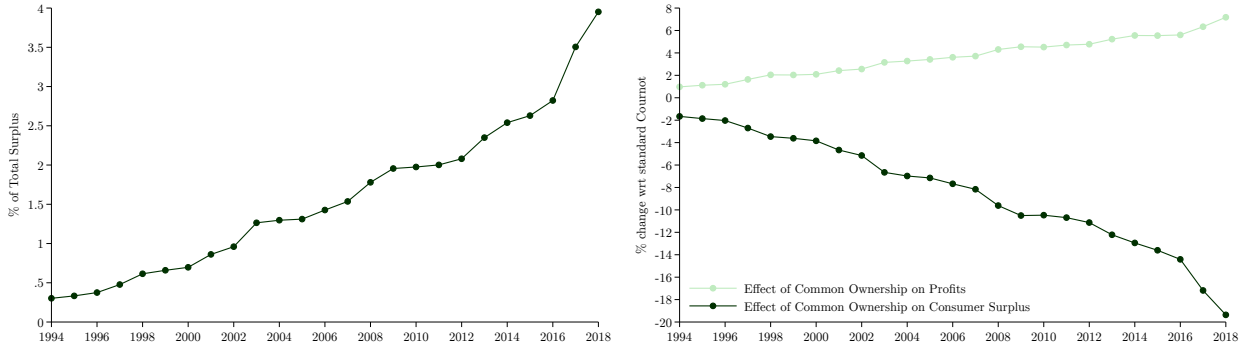


FIGURE NOTES: The left panel of the figure above plots the deadweight loss from common ownership, measured as the difference in Total Surplus (W) between the Cournot oligopoly allocation and the CCO allocation. The right panel displays the effect of common ownership on profits and consumer surplus, measured as the percentage difference between the Cournot oligopoly allocation and the CCO allocation. Yearly data from 1994-2018.

We construct blockholding-consistent common ownership weights, based on the alternative assumption that investors exert influence only when their ownership stake exceeds the 5% blockholder threshold in a company. That is, if some investor z is a blockholder of firm i, the firm is assumed to internalize the impact of its production decision on the investor's portfolio profits. Otherwise, the impact on the investor's portfolio profits is disregarded and the investor's portfolio profits are assumed to coincide with the firm's profit function. Specifically, the manager i's objective function becomes:

$$\phi_i \quad = \quad \pi_i \sum_{z=1}^{Z} s_{iz} s_{iz} + \sum_{j \neq i} \pi_j \sum_{z=1}^{Z} s_{iz} b_{iz} s_{jz} \tag{5.2}$$

where b_{iz} is a dummy variable that identifies whether investor z is a blockholder of company i. The blockholder-adjusted common ownership weights are thus given by

$$\tilde{\kappa}_{ij} \quad \stackrel{\text{def}}{=} \quad \frac{\sum_{z=1}^{Z} s_{iz} b_{iz} s_{jz}}{\sum_{z=1}^{Z} s_{iz} s_{jz}} \quad \text{for } i \neq j \tag{5.3}$$

in line with the SEC's definition of a "blockholder." We assume that $b_{iz} = 1$ if and only if $s_{iz} > 5\%$.

5.1.3 Rational Investor Inattention

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 (2020, 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 a 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 produces the following alternative measure of firm i's sympathy towards firm j:

$$\text{GGL}_{ij}^{\text{full}} \quad \stackrel{\text{def}}{=} \quad \mathbf{s}_i'\mathbf{s}_j \quad \equiv \quad \sum_{z=1}^{Z} s_{iz}s_{jz} \tag{5.4}$$

While GGL's sympathy score differs from the welfare-relevant measure of common ownership in our structural model (κ_{ij}), the two metrics are closely related. It can be immediately verified that

$$\kappa_{ij} \;=\; \frac{\text{GGL}_{ij}^{\text{full}}}{\text{IHHI}_i} \tag{5.5}$$

where IHHI_i is the investor Herfindahl index of firm i. This specific measure of common ownership, just like κ_{ij}, presumes that investors are fully attentive to the product market interactions of the firms in their portfolio. GGL generalize their measure to a setting where investors are allowed to be imperfectly attentive:

$$\text{GGL}_{ij}^{\text{fitted}} \quad \stackrel{\text{def}}{=} \quad \sum_{z=1}^{Z} s_{iz}\, g_{iz}\, s_{jz} \tag{5.6}$$

where $g_{iz} \in [0, 1]$ is an "attention weight," which captures the degree to which investor z internalizes the product market rivalries of firm i. Following Iliev and Lowry (2015)'s approach of using proxy voting data, GGL estimate these attention weights non-parametrically as the probability of investor z deviating from the voting recommendation issued by the Institutional Shareholders Service (ISS), conditional on the weight of firm i in investor z's portfolio. They find that the higher the weight of firm i in z's portfolio, the higher the likelihood of z deviating from ISS's recommendation. The intuition behind this measure is that an inattentive investor will completely delegate their voting choices to ISS and never disagree with their recommendation. The assumption is that ISS itself does not base their voting recommendations on product market rivalry considerations.

We can use the attention weights of GGL to compute a modified κ_{ij} that accounts for imperfect investor attention. To do so, however, we need to make an assumption about the ex-ante probability that a fully-attentive investor disagrees with ISS. Because the disagreement probabilities estimated by GGL top out at 7% (i.e., the probability in the limit case in which a company comprises the entirety of an investor's portfolio), we assume that 7% is the disagreement probability in the full attention case. This assumption is consistent with investors paying full attention to companies that make up the entirety of their portfolio.

FIGURE 8: COMMON OWNERSHIP DWL - ALTERNATIVE GOVERNANCE MODELS

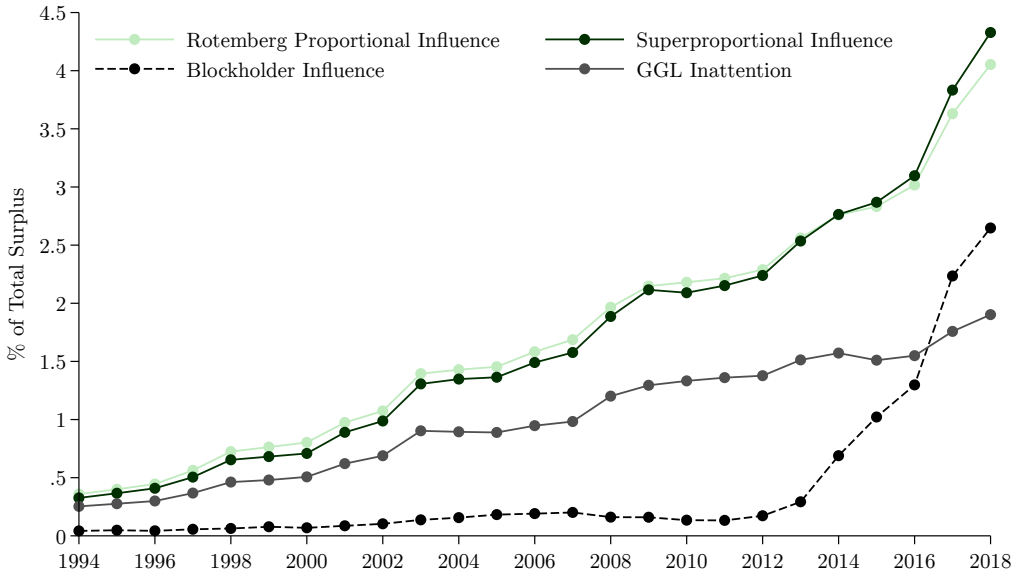


FIGURE NOTES: The figure plots the deadweight loss of common ownership, computed as % of the total surplus, under proportional, superproportional and blockholder influence models, and the GGL inattention model using yearly data from 1994 to 2018.

This leads to the following modified sympathy weight $\bar{\kappa}_{ij}$ given by

$$\bar{\kappa}_{ij} \overset{\text{def}}{=} \frac{1}{0.07} \cdot \frac{\text{GGL}_{ij}^{\text{fitted}}}{\text{IHHI}_i} = \frac{1}{0.07} \cdot \underbrace{\frac{\text{GGL}_{ij}^{\text{fitted}}}{\text{GGL}_{ij}^{\text{full}}}}_{<0.07} \cdot \kappa_{ij} \tag{5.7}$$

which can be computed using the data of GGL which is available on the WRDS platform.

This measure can be micro-founded with a behavioral governance model in which firm i's management discounts investor z's share of the competitors' profits at a rate g_{iz}, which is consistent with the following objective function for firm i:

$$\phi_i = \pi_i \sum_{z=1}^{Z} s_{iz} s_{iz} + \sum_{j \neq i} \pi_j \sum_{z=1}^{Z} s_{iz} g_{iz} s_{jz} \quad \text{for } i \neq j \tag{5.8}$$

Note that, by construction, $0 \leq \tilde{\kappa}_{ij} \leq \kappa_{ij}$. Therefore, in the framework of GGL, investor inattention dampens the product market effects of common ownership.

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.

In Figure 8 we plot the evolution of the deadweight loss that is due to the presence of common

FIGURE 9: DISTRIBUTIONAL EFFECTS - ALTERNATE GOVERNANCE MODELS (1994-2018)

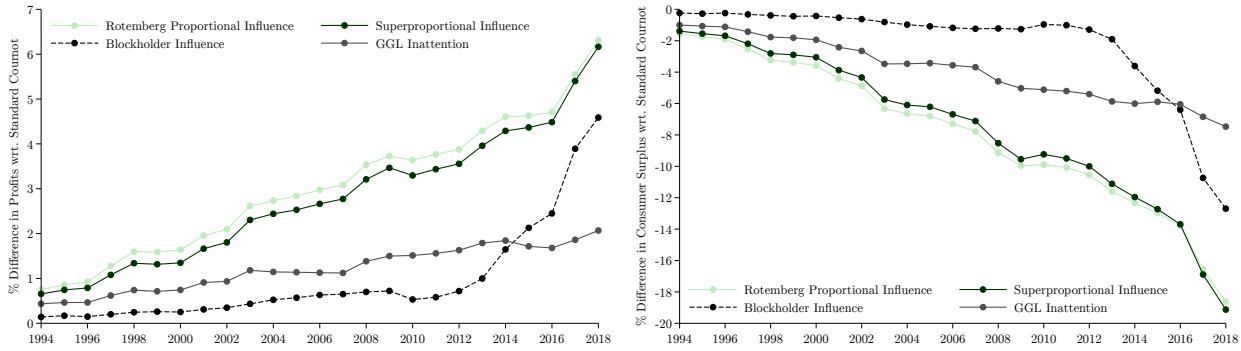


FIGURE NOTES: The figure shows the effect of common ownership on profits (left panel) and consumer surplus (right panel), measured as the percentage difference between the Cournot and the CCO allocation. Yearly data from 1994 to 2018.

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 is 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 U.S. whereas twenty years ago that number was zero percent for both firms (Fichtner et al., 2017). Finally, the deadweight loss estimates of common ownership under the GGL inattention model hover between the blockholder and proportional influence models until 2014. Even under GGL inattention, common ownership leads to a deadweight loss of almost 2% of total surplus, much higher than in 1994. One caveat of our empirical implementation of the GGL inattention model is that GGL's data are only available up to 2012. For the years following 2012 we have to use the 2012 attention weights. This means that while the modified sympathy weights $\bar{\kappa}_{ij}$ still capture the increase in ownership concentration that takes place in this period, they fail to reflect changes in (in)attention that may have taken place at the same time.

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 Π 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 Π and W. This allows us to investigate whether the higher economic profits are somehow justified by higher fixed costs.

In Figures 10 and 11 in the appendix we show the evolution of the profit share and the deadweight loss after redefining Π 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 10 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*. As a result, some argue that it should not be treated as overhead but should instead 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:

$$f_i \;=\; (\text{SGA}_i - \text{R\&D}_i) \times 0.7 + (\text{PPE}_i + \text{Intangible Capital}_i) \times \text{User Cost of Capital} \tag{5.9}$$

Figures 12 and 13 use this alternative measure of fixed costs in which intangible investments are capitalized rather than expensed. Our results are largely unaffected by using this alternative measure of fixed costs.

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 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 continue to hold for 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.

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.

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Appendices

A Tale of Two Networks:
Common Ownership and Product Market Rivalry

Florian Ederer (Yale) & Bruno Pellegrino (UMD)

A Correction for Unobserved Ownership

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 κ_{ij}. We start by rewriting κ_{ij} in the following way:

$$\kappa_{ij} \;=\; \frac{\mathbf{s}_i'\mathbf{s}_j}{\text{IHHI}_i} \tag{A.1}$$

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 $\mathcal{U}$ the set of Unobserved Investors.

Importantly, the denominator of the of 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 κ_{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:

$$\sum_{z\in\mathcal{U}} s_{iz}s_{jz} = 0 \tag{A.2}$$

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 IHHI using observed investors only we obtain:

$$\widehat{\text{IHHI}}_i \;=\; \sum_{k\in\mathcal{O}} s_{iz}^2 \tag{A.3}$$

a downward biased estimate of the IHHI. For some firms, where few small investors are observed, this bias can be enormous, leading κ to exceed 10,000. Let us write the "true" IHHI as

$$\text{IHHI}_i^* \;=\; \sum_{z\in\mathcal{O}} s_{iz}^2 + \sum_{z\in\mathcal{U}} s_{iz}^2 \tag{A.4}$$

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

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

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:

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

As a result we have

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

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 $\left(\text{IHHI}_i^{\mathcal{O}} = \text{IHHI}_i^{\mathcal{U}}\right)$, and using the fact that

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

the true Herfindahl index can be rewritten as:

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

B Welfare Estimates and Fixed Costs

In this appendix, we provide welfare estimates for the beginning of our sample as well as for the end of our sample when all κ_{ij} are restricted to be smaller than 1. We further recompute our estimates of the evolution of the profit share and the deadweight loss over time using different definitions of aggregate profits that subtract fixed costs.

TABLE 3: WELFARE ESTIMATES (1994)

	Scenario	*Common Ownership*	*Cournot-Nash*	*Perfect Competition*	*Monopoly*
		(1)	(2)	(3)	(4)
Welfare Statistic	**Variable**	$\mathbf{q}^{\Xi}$	$\mathbf{q}^{\Psi}$	$\mathbf{q}^{W}$	$\mathbf{q}^{\Pi}$
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	$\frac{\mathrm{CS}(\mathbf{q})}{W(\mathbf{q})}$	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 4: WELFARE ESTIMATES (2017) FOR $\kappa_{ij} \leq 1$

	Scenario	*Common Ownership*	*Cournot-Nash*	*Perfect Competition*	*Monopoly*
		(1)	(2)	(3)	(4)
Welfare Statistic	**Variable**	$\mathbf{q}^{\Xi}$	$\mathbf{q}^{\Psi}$	$\mathbf{q}^{W}$	$\mathbf{q}^{\Pi}$
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	$\frac{\text{CS}(\mathbf{q})}{W(\mathbf{q})}$	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: Profit Share of Total Surplus Net of Fixed Costs

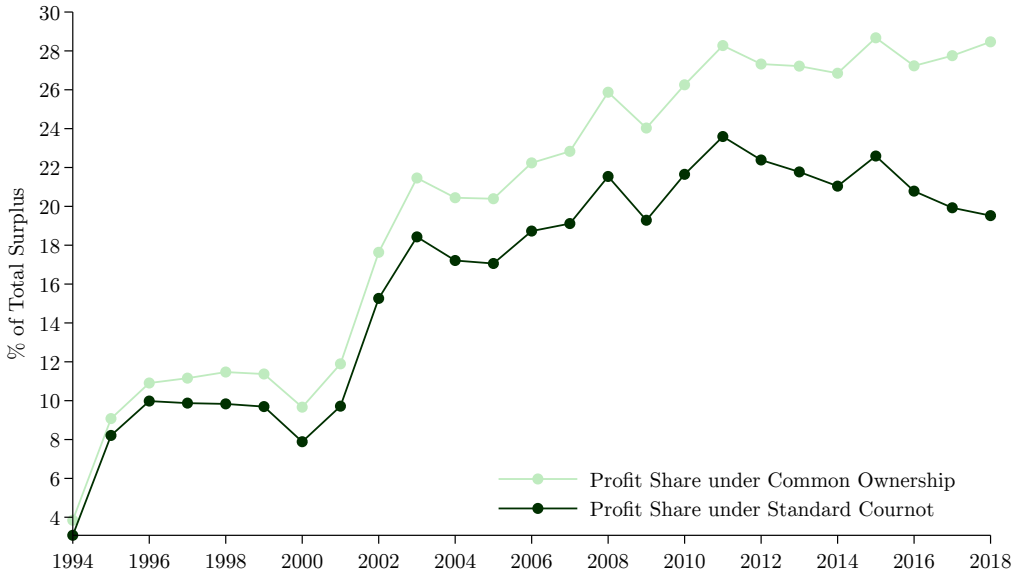


Figure Notes: The figure plots the profit share net of fixed costs under standard Cournot (dark green line) and Cournot with common ownership (light green line) between 1994 and 2018.

Figure 11: Deadweight Loss Net of Fixed Costs

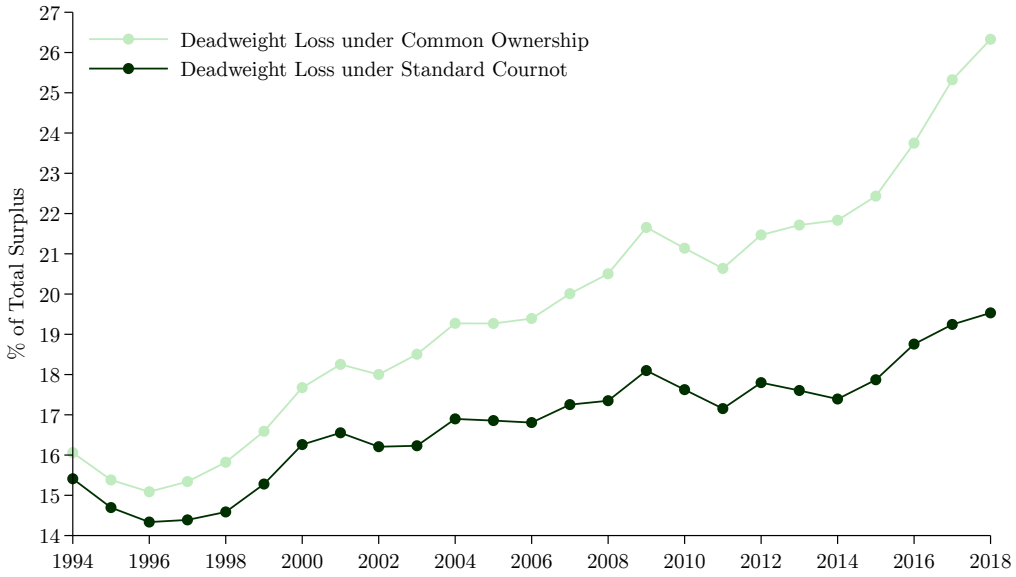


Figure Notes: The figure plots the estimated deadweight loss (DWL) of oligopoly and of oligopoly and common ownership, between 1994 and 2018. The dark green line is the DWL of oligopoly, the % difference in total surplus between the Cournot equilibrium and the Perfect Competition scenario. The light 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 12: Profit Share Net of Fixed Costs (Alternative Computation)

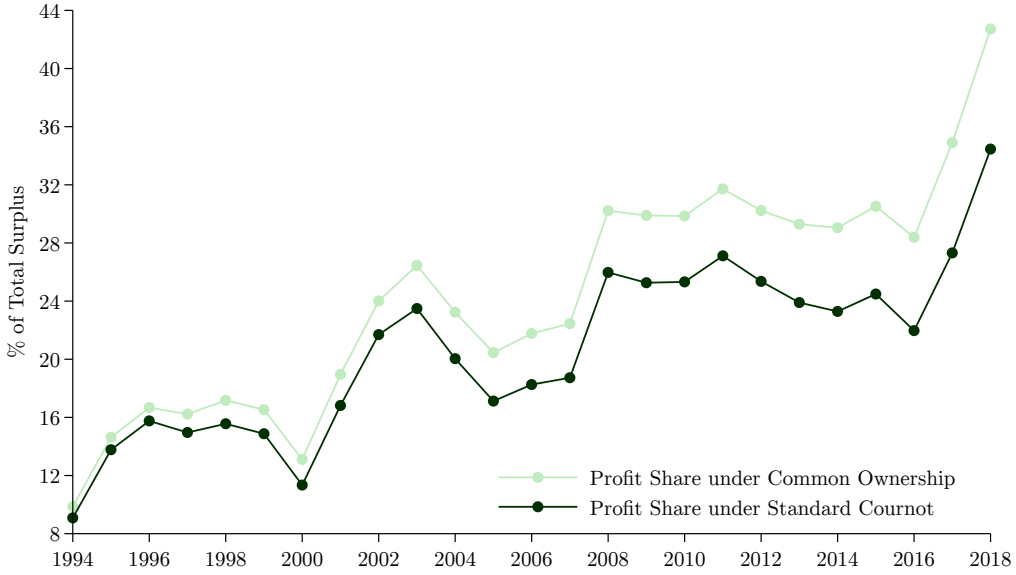


Figure Notes: The figure plots the profit share net of fixed costs under standard Cournot (dark green line) and Cournot with common ownership (light green line) between 1994 and 2018. Intangible investments are capitalized rather than expensed.

Figure 13: Deadweight Loss Net of Fixed Costs (Alternative Computation)

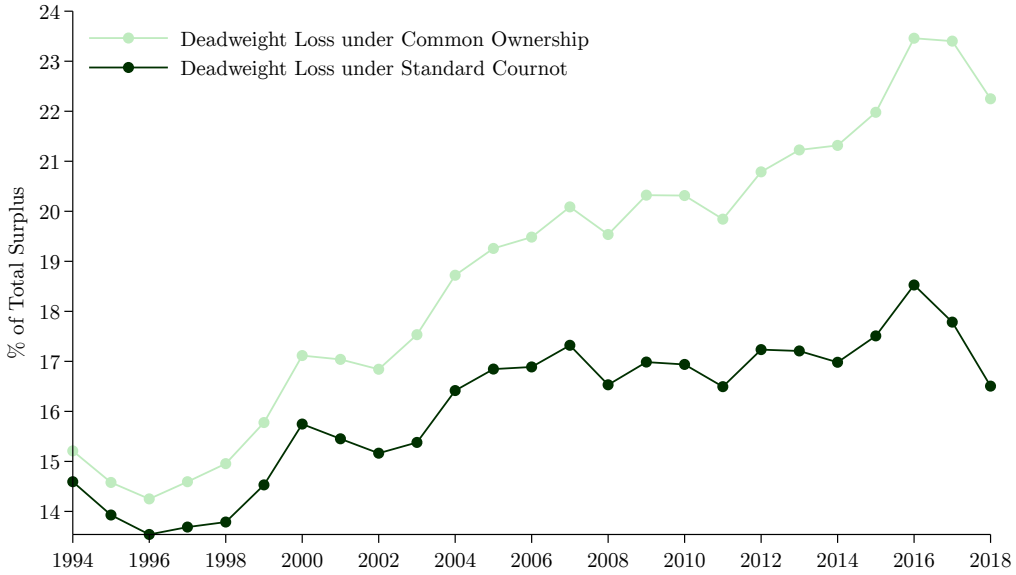


Figure Notes: The figure plots the estimated deadweight loss (DWL) of oligopoly and of oligopoly and common ownership, between 1994 and 2018. The dark green line is the DWL of oligopoly, the % difference in total surplus between the Cournot equilibrium and the Perfect Competition scenario. The light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

FIGURE 14: REVENUE-WEIGHTED AVERAGE MARKUP

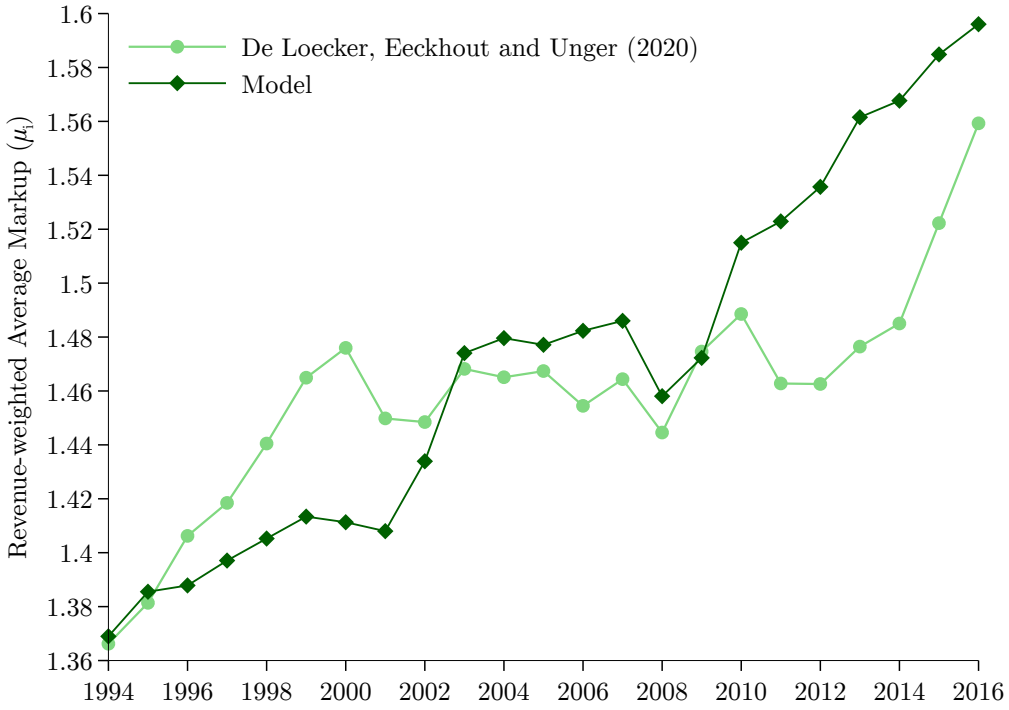


FIGURE NOTES: The figure plots the time series of average markups estimated by our model (dark green line) and by DEU (light green line).

C Calibration

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 and cross-price demand elasticities to correlate with existing econometric estimates.

C.1 Time-series Variation in Markups

To show that it is appropriate to apply Pellegrino (2019)'s α and $\tilde{\delta}$ to our model (despite the change in conduct assumption), we compute markups and cross-price elasticities based on these calibrated values and compare them to empirical values exactly in the same fashion as Pellegrino (2019).

Pellegrino (2019) shows that firm i's markup can be written as a function of the firm's capital k_i, revenues π_i, total cost h_i, and the parameter $\tilde{\delta}$. He then 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).

Like Pellegrino (2019), we show that our aggregate markup series matches closely that of DEU, with one minor difference. In our model, we cannot compute markups without an estimate of $\mathbf{\Sigma}$

FIGURE 15: CALIBRATED MARKUPS VS. DEU

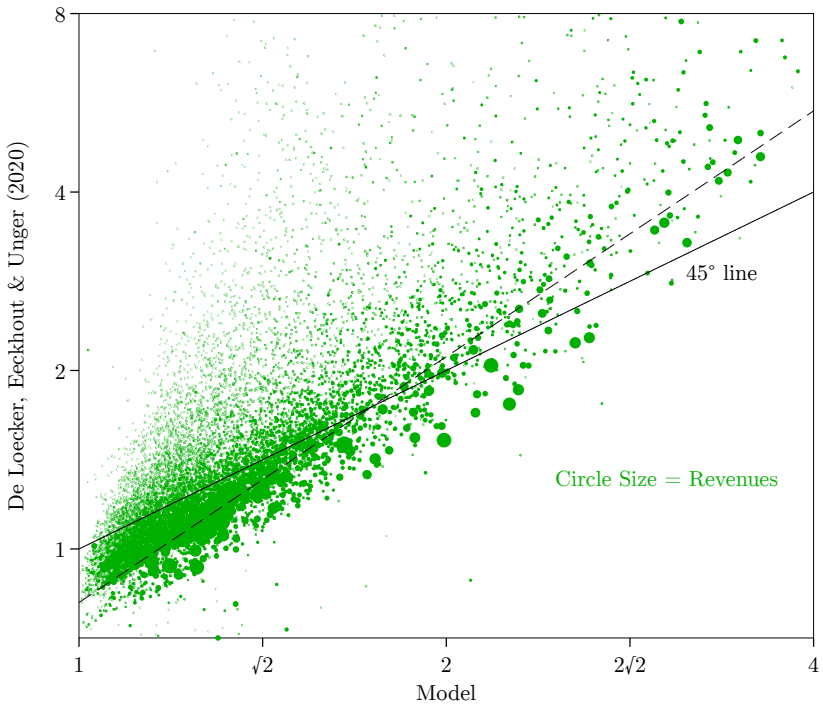


FIGURE NOTES: The figure plots the cross-section of markups obtained from the model against DEU's estimates with the size of the circle representing each firm's revenues.

and **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. Figure 14 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.

C.2 Cross-sectional Variation in Markups and Cross-Price Demand Elasticities

We further 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 15, 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 revenues (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

TABLE 5: MICROECONOMETRIC ESTIMATES OF CROSS-PRICE DEMAND ELASTICITIES

Industry	Citation	Journal/Series
Auto	Berry, Levinsohn and Pakes (1995)	Econometrica
Beer	De Loecker and Scott (2016)	NBER Working Papers
Cereals	Nevo (2001)	Econometrica
Drugs	Chintagunta (2002)	Journal of Marketing Research
Laptops	Goeree (2008)	Econometrica

remarkable 88% of the cross-sectional variation in markups (as measured by the R^2 of a regression where the slope is constrained to one).

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 estimates that were used to calibrate the parameter α. Our strategy for calibrating α 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 industrial organization studies described in Table 5. These estimates of the cross-price demand elasticity are then manually matched to the corresponding firm pair in Compustat. To calibrate α, we can rewrite equation (2.18) as:

$$\left|\frac{\partial \log p_i}{\partial \log q_j}\right| = \alpha \cdot \mathbf{a}_i' \mathbf{a}_j \frac{q_j}{p_i} \quad \forall\, i \neq j \tag{C.1}$$

Finally, for each firm pair, we can obtain an estimate of α by rearranging equation (C.1):

$$\hat{\alpha}_{ij} = \left|\frac{\partial \log p_i}{\partial \log q_j}\right| \Big/ \left(\mathbf{a}_i' \mathbf{a}_j \frac{q_i}{p_i}\right) \tag{C.2}$$

Equation (C.2) can be rearranged as

$$\log \left|\frac{\partial \log p_i}{\partial \log q_j}\right| \approx \log \alpha + \log \left(\mathbf{a}_i' \mathbf{a}_j \frac{q_j}{p_i}\right) \tag{C.3}$$

where we use the symbol $\approx$ to denote the fact that measurement error contaminates what should be a linear-in-logs relationship.

By calibrating α, we are only able to choose the intercept of this linear relationship, not the

Table 6: 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 with Data (in logs)	1.000	0.584	No
Number of Observations	32	32	

slope nor the correlation. We use the (untargeted) slope and the goodness-of-fit of equation (C.3) to evaluate the model fit.

In Table 6, we report the relationship between the microeconometric estimates (i.e., the left side of equation C.3) from the industry studies listed in Table 5 and our own model-based estimates that use the calibrated value of α. Each observation is a firm pair (i, j) of a microeconometric industry study from which the estimates are sourced.

Despite the fact that we cannot affect the slope of the relationship by calibrating α there is a strong positive correlation between the two series. The correlation between the industry study estimates and our own model-implied estimates is 0.584, which is particularly high if we consider that the microeconometric estimates were obtained by the respective authors using different assumptions about the underlying demand system, as well as different econometric methodologies.