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

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January 15, 2025

Abstract

We study the welfare implications of the rise of common ownership in the United States from 1995 to 2021. We build 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 and the magnitude of the common ownership effect depends on how much the 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. Under the assumption that firms maximize a share-weighted average of their shareholders' income, we find that the welfare cost of common ownership, measured as the ratio of deadweight loss to total surplus, has increased about ninefold between 1995 and 2021. Under alternative assumptions about corporate governance, the deadweight loss of common ownership ranges between 3.5% and 13.2% of total surplus in 2021. The rise of common ownership has also led to a significant reallocation of surplus from consumers to producers.

JEL Codes: D43, D85, E23, L16, G23, G34

Keywords: common ownership, corporate governance, networks, institutional investors, oligopoly

*We thank John Asker, José Azar, Matt Backus, Paul Beaumont, Matteo Benetton, Pietro Bonaldi, Chris Conlon, Jacob Conway, Jan De Loecker, Jan Eeckhout, Matt Elliott, Murray Frank, Francesco Franzoni, Laurent Frésard, Mishel Ghassibe, Erik Gilje, Paul Goldsmith-Pinkham, Ben Golub, Todd Gormley, Jerry Hoberg, Hugo Hopenhayn, Oleg Itskhoki, Karam Kang, Pete Kyle, Doron Levit, Tong Liu, Song Ma, Abdoulaye Ndiaye, Gordon Phillips, Noémie Pinardon-Touati, Douglas Rathbun, Nikolai Roussanov, Martin Schmalz, Fiona Scott Morton, Jesse Shapiro, Mike Sinkinson, Steve Tadelis, Venky Venkateswaran, Russ Wermers, Tom Wollmann, Yufeng Wu, Leeat Yariv, Luigi Zingales, and seminar participants at AEA, AFA, ALEA, APIOC, Berlin, Berkeley, BSE Summer Forum, Cambridge Judge, the Cambridge Network Economics Conference, CEPR FirmOrgDyn, Copenhagen, Columbia, Duke, the Econometric Society Meetings, the Federal Trade Commission, FOM, Georgetown, GMU, HBS, HEC, HKUST, Maastricht, Michigan, NBER Organizational Economics, NBER Megafirms, NYU Stern, Red Rock Finance Conference, Rice, SAET, SED, Stanford, Strategy Science, Tilburg, Tsinghua, UCL, UCLA, UMD, UNC, University of Toronto, USC Marshall, USI/Swiss Finance Institute, UW Foster, Virginia, and Yale for helpful comments. Aslihan Asil, Ian Veidenheimer, and Gurmehar Sidhu provided outstanding research assistance. We gratefully acknowledge grant funding from the Washington Center for Equitable Growth.

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1 Introduction

Over the last three decades the ownership of corporate equity in the United States has become increasingly concentrated in the hands of a few large institutional investors (Ben-David, Franzoni, Moussawi and Sedunov, 2020), a trend known as the rise of common ownership (Azar, 2012; Gilje, Gormley and Levit, 2020; Backus, Conlon and Sinkinson, 2021b). Common ownership describes a structure in which large investors hold significant stakes in several competing firms. The tremendous increase of common ownership has raised concerns among policymakers (see, for example, Phillips (2018) and Vestager (2018)) because it may lessen firms' economic incentives to aggressively compete against each other. If firms make strategic decisions to maximize the profits accruing to their 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 paper studies the increasing concentration of the network of firm ownership as well its overlap with the network of product market competitors to show that the resulting welfare costs and distributional consequences are significant.

Concerns about the harm of common ownership are supported by a long-standing and growing academic literature, starting with Rubinstein and Yaari (1983) and Rotemberg (1984), that studies oligopolistic behavior in the presence of common ownership. In response to the secular rise of common ownership and the concurrent surge of empirical research on its anticompetitive effects (see Schmalz (2018) for a recent survey and Shekita (2022) for a collection of specific examples), antitrust authorities and financial regulators around the world (including the Department of Justice, the Federal Trade Commission, the European Commission, and the Securities and Exchange Commission) have begun studying policy measures to address them.[1] Despite the enormous academic and policy interest in common ownership, as of today, there has been no attempt to quantify its aggregate welfare impact.

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, commonly-owned firms compete in a network game of oligopoly. Building on the rich literature on linear-quadratic network games (Ballester, Calvó-Armengol and Zenou, 2006; Ushchev and Zenou, 2018; Galeotti, Golub and Goyal, 2020), the firms in our model are connected through two large networks: the first reflects ownership overlap, the second product

[1] Solomon (2016) reported on an investigation based on Senate testimony by the head of the Antitrust Division, the Federal Trade Commission (2018) featured a hearing on common ownership, and Vestager (2018) disclosed that the European Competition Commission is "looking carefully" at common ownership given indications of its increase and potential for anticompetitive effects. The Federal Trade Commission and Department of Justice (2022) are currently requesting public comments on how the agencies can modernize enforcement of the antitrust laws regarding mergers including the merger "guidelines' approach to common ownership and horizontal stockholding." For other recent activity, see OECD (2017), European Competition Commission (2017), and Jackson (2018).

similarity.

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 1995 to 2021. We perform counterfactual calculations to evaluate how the efficiency and the distributional impact of common ownership have evolved over this period, finding large negative consumer welfare effects.

Our model has two distinctive features. First, following the literature on hedonic demand (Lancaster, 1966; Rosen, 1974) it leverages the Generalized Hedonic-Linear (GHL) demand system recently developed by Pellegrino (2019). This demand system is based on the assumption that there is a representative consumer who has quadratic preferences over product characteristics (as opposed to products). The cross-price elasticity of demand between any two products is thus proportional to a metric of product similarity which captures whether two products contain similar attributes. This setup allows us to estimate, using the dataset of Hoberg and Phillips (2016), realistic cross-price demand elasticities specific to each firm pair and year, without having to take a stance on industry boundaries. Second, firms make strategic supply decisions with the objective of maximizing 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, 2019; 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 other company receiving a weight proportional to a well-defined measure of common ownership that can be computed using 13(f) institutional investor holdings data. A key feature of our model is that the anticompetitive effects of common ownership depend on the overlap between the two networks of product similarity and common 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, managerial incentives, 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 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

[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 further consider neither coordinated anticompetitive effects of common ownership which may result from explicit or tacit collusion between firms or owners as documented by Shekita (2022) nor beneficial effects such as the internalization of innovation spillovers (**??**). We also do not analyze the effect of common ownership on risk-taking and portfolio diversification by financial institutions, which has been studied separately by Galeotti and Ghiglino (2021). Thus, our analysis focuses exclusively on the welfare *costs* of *unilateral product market* effects of common ownership.

on product similarity and ownership networks.

We first 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 quite as large as the welfare costs of oligopoly. We estimate that in 2021, 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 opposed to competing as under perfect competition) amounts to about 13.9% of total surplus. Common ownership leads to an additional deadweight loss of 12.4% 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 2021 common ownership raises aggregate profits by \$1.133 trillion (from \$2.167 trillion to \$3.300 trillion), but lowers consumer surplus by \$2.399 trillion (from \$7.402 trillion to \$5.003 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 1.4% in 1995 this deadweight loss increased to 13.2% in 2021. We also document significant redistribution of surplus. Common ownership raised corporate profits by 11.4% in 1995 and by 52.3% in 2021, but lowered consumer surplus by 3.8% in 1995 and by 32.4% in 2021.

We further explore how alternative assumptions about corporate governance modify our 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.[3] Under such an alternative "superproportional influence" assumption, common ownership has essentially identical effects on deadweight loss, corporate profits, and consumer surplus. 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 deadweight losses of 9.2% and 10.2% of total surplus in 2021. Even our most conservative estimates which we obtain under a model of corporate governance that recognizes the frictions arising from managerial

[3]Several large institutional investors such as BlackRock and TIAA-CREF have also argued for stronger "stakeholder capitalism" which takes the interests of stakeholders other than owners (e.g., employees and consumers) into account and seeks to internalize all the externalities that companies impose on "the society where they work and operate" (Fink, 2020), as well as to support broader goals of social responsibility (Hart and Zingales, 2017; Oehmke and Opp, 2019; Broccardo, Hart and Zingales, 2020). Our analysis builds on the arguably less ambitious assumption that investors influence companies to partially internalize only the effect on product market profits that their corporate conduct imposes on other firms in the same investors' portfolio.

entrenchment, point to deadweight losses of around 3.5% of total surplus. Finally, we show that our conclusions continue to hold under a number of extensions including the presence of private and foreign firms, multi-product firms, complements, overlap in the consumption baskets of corporate managers and the representative agent, decreasing returns to scale, and when excluding firms in non-tradable industries.

Our paper contributes to several literatures. First, it builds on the macroeconomic networks literature (Acemoglu, Carvalho, Ozdaglar and Tahbaz-Salehi, 2012; Carvalho, 2014; Acemoglu, Ozdaglar and Tahbaz-Salehi, 2017; Carvalho and Tahbaz-Salehi, 2019; Liu and Tsyvinski, 2020; Carvalho, Nirei, Saito and Tahbaz-Salehi, 2021a; Carvalho, Elliott and Spray, 2021b). Whereas those papers focus on input-output networks we study networks of ownership and product market rivalry. As a result, our work shares similarities with Bloom, Schankerman and Van Reenen (2013) who empirically study innovation spillovers through product market and technology networks, and with Chen, Zenou and Zhou (2018, 2021) and Galeotti, Golub, Goyal, Talamàs and Tamuz (2021) who theoretically analyze the role of market structure and market power in networks.

Second, our work is related to the growing body of academic work on markups (De Loecker, Eeckhout and Unger, 2020; De Loecker and Eeckhout, 2018; Autor, Dorn, Katz, Patterson and Van Reenen, 2020; Döpper, MacKay, Miller and Stiebale, 2021), industry concentration Grullon, Larkin and Michaely (2019); Hsieh and Rossi-Hansberg (2019); Benkard, Yurukoglu and Zhang (2021), and, most importantly, the social cost of markups (Edmond, Midrigan and Xu, 2018; Boar and Midrigan, 2019; Pellegrino, 2019; Baqaee and Farhi, 2020).[4] By incorporating hedonic demand as well as data on product market similarity and ownership we characterize competitive interactions between firms that differ by their productivity as well by their products' characteristics and their ownership, including the connections that exist between the latter two features.

Finally, our paper contributes to the burgeoning literature on common ownership. Several empirical papers (Matvos and Ostrovsky, 2008; Azar, Schmalz and Tecu, 2018; Boller and Scott Morton, 2020; Newham, Seldeslachts and Banal-Estanol, 2019; Xie and Gerakos, 2020; Li, Liu and Taylor, 2020; Antón, Ederer, Giné and Schmalz, 2023b; Dennis, Gerardi and Schenone, 2020; Eldar, Grennan and Waldock, 2020; Lewellen and Lowry, 2021; Azar, Raina and Schmalz, 2021; Backus, Conlon and Sinkinson, 2021a; Saidi and Streitz, 2021; Azar and Ribeiro, 2022) investigate whether common ownership affects firm decisions and industry outcomes (e.g., prices, quantities, markups, entry, managerial compensation, innovation). The evidence is mixed and growing as this is a very active area of research. Results vary across industries, outcome variables, and the specific methodologies used to estimate the various effects of common ownership.

Azar and Vives (2021a) theoretically study common ownership in a general equilibrium setting in which symmetric common ownership across identical, symmetrically-differentiated oligopolistic

[4] 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).

firms leads to additional market power with respect to both product market competition and labor hiring. In contrast to their paper, our theoretical model assumes competitive labor markets to focus on the product market effects of common ownership but allows for arbitrary size differences and substitution patterns between firms. Furthermore, in addition to laying out a theoretical framework, we structurally estimate our model using granular, time-varying firm-by-firm and firm-by-investor network microdata and obtain detailed welfare estimates, including the effect of common ownership on individual firms' profits.

In sum, a key difference between our study and all previous contributions on common ownership is that we espouse a macro-structural methodological framework that combines theory and data with the objective of answering an entirely distinct research question: Assuming that firms *do* maximize shareholder value (as opposed to own-firm profits), what are the economy-wide welfare and distributional consequences of common ownership?

By taking a network approach to modelling inter- and intra-industry competition, as predicated by Elliott and Galeotti (2019), we can overcome the problem of external validity (a natural limitation of industry studies), as we compute the welfare impact of common ownership for a broad set of industries. Additionally, because we model the product market as a network, we do not face the problem of having to arbitrarily define the relevant product markets, which is a source of model uncertainty in industry studies. Our analysis shows that, at the aggregate level, common ownership can generate significant distortions and reallocation of surplus—even under conservative assumptions about the effect of common ownership on corporate governance.

The remainder of the paper proceeds 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 empirical results under a range of different corporate governance models and Section 6 discusses a number of extensions. Section 7 concludes.

2 Theoretical Model

Building on Pellegrino (2019) we develop a general equilibrium model in which granular firms with overlapping ownership compete in a network game of Cournot oligopoly.

2.1 Generalized Hedonic-Linear (GHL) Demand

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 the firms in the economy.

Our economy has n firms, indexed by $i \in \{1, 2, \ldots, n\}$. Each firm produces a single differentiated product such that there are n products in the economy. The representative agent has hedonic demand (Lancaster, 1966; Rosen, 1974) and thus values each product as a bundle of its constituent characteristics.[5]

Each product has two types of characteristics: m common characteristics indexed by $\iota \in \{1, 2, \ldots, m\}$ and one of n idiosyncratic characteristics. We assume that firms' product characteristics are exogenously given. Neither the product market nor firms' ownership structure influence the product positioning of firms. The m-dimensional column vector $\mathbf{a}_i$ describes product i where the scalar $a_{\iota i}$ is the number of units of common characteristic ι of product i. The column vector $\mathbf{a}_i$ is of unit length:

$$\mathbf{a}_i \;=\; \begin{bmatrix} a_{1i} & a_{2i} & \ldots & a_{mi} \end{bmatrix}' \quad \text{such that} \quad \sum_{j=1}^{m} a_{ji}^2 = 1 \quad \forall\, i \in \{1, 2, \ldots, n\} \tag{2.1}$$

We combine the product-specific vectors $\mathbf{a}_i$ of common characteristics in the $m \times n$ matrix $\mathbf{A}$.

The representative agent consumes q_i units of the good produced by firm i. The n-dimensional vector $\mathbf{q}$ contains the quantities of the n firms in the economy. An *allocation* is a vector $\mathbf{q}$ that specifies how many units q_i of each good i are produced. The total units x_j of common characteristic j consumed by the representative agent are given by

$$x_j \;=\; \sum_i a_{ji} q_i \tag{2.2}$$

so that $\mathbf{x} = \mathbf{Aq}$ (i.e., the matrix $\mathbf{A}$ converts units of goods $\mathbf{q}$ into the vector of consumed common characteristics $\mathbf{x}$). Each unit of good i contains exactly one unit of its own idiosyncratic characteristic and hence $\mathbf{y} = \mathbf{q}$ (i.e., the vector of consumed idiosyncratic characteristics $\mathbf{y}$ is equal to the vector of consumed quantities $\mathbf{q}$).

The representative agent has a utility function which is quadratic in common and idiosyncratic characteristics of the products consumed, and suffers a linear disutility for the total number of work hours H. The utility function is therefore given by

$$U(\mathbf{x}, \mathbf{q}, H) \;\stackrel{\text{def}}{=}\; \alpha \cdot \sum_{j=1}^{m} \left(b_j^x x_j \,-\, \frac{1}{2}\, x_j^2 \right) + (1 - \alpha) \sum_{i=1}^{n} \left(b_i^y y_i \,-\, \frac{1}{2}\, y_i^2 \right) - H \tag{2.3}$$

where $\alpha \in [0, 1]$ is the utility weight of common characteristics relative to idiosyncratic characteristics which provides an additional degree of *horizontal differentiation* between products. If $\alpha = 0$, the consumer only cares about idiosyncratic characteristics and all the firms in the economy are monopolists producing independent products. In contrast, if $\alpha = 1$ the consumer's utility only de-

[5]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.

pends on common characteristics.[6] b^x_j and b^y_i are preference shifters for common and idiosyncratic characteristics. We close the general equilibrium model by letting leisure be the outside good.

The representative agent purchases and consumes the goods bundle $\mathbf{q}$ taking prices $\mathbf{p}$ as given, receives labor income H and also receives the aggregate profits $\Pi = \sum_{i=1}^{n} \pi_i$ from owning shares of all the companies in the economy.[7] Each firm i's profit is denoted by π_i. The agent's budget constraint is thus given by

$$H + \Pi \geq \sum_{i=1}^{n} p_i q_i. \tag{2.4}$$

Labor is the numéraire of this economy. The consumer's demand function $\mathbf{q}(\mathbf{p})$ maximizes the consumer surplus function

$$\mathrm{CS}(\mathbf{q}) \quad = \quad \mathbf{q}'(\mathbf{b}-\mathbf{p}) - \frac{1}{2}\mathbf{q}'\left[\mathbf{I} + \alpha\left(\mathbf{A}'\mathbf{A} - \mathbf{I}\right)\right]\mathbf{q} \tag{2.5}$$

where

$$\mathbf{b} \quad \stackrel{\text{def}}{=} \quad \alpha\,\mathbf{A}'\mathbf{b}^x + (1-\alpha)\,\mathbf{b}^y. \tag{2.6}$$

$\mathbf{a}_i'\mathbf{a}_j$ is the *cosine similarity* between i and j and ranges from 0 to 1. The cosine similarities between all firm pairs are contained in the matrix $\mathbf{A}'\mathbf{A}$. When two products overlap more in the characteristics space, they have a higher cosine similarity and are more substitutable.

Define the following symmetric matrix

$$\mathbf{\Sigma} \stackrel{\text{def}}{=} \alpha\left(\mathbf{A}'\mathbf{A} - \mathbf{I}\right). \tag{2.7}$$

and let its entries be denoted by σ_{ij}. The diagonal elements σ_{ii} of $\mathbf{\Sigma}$ are equal to 0 and the off-diagonal elements σ_{ij} are bounded between 0 and α. In the limit case where $\sigma_{ij} = 0$, the two products are maximally differentiated and independent because they share no characteristics. If, in contrast, $\sigma_{ij} = \alpha$, the two products are maximally substitutable and have exactly the same common characteristics. They are only differentiated to the extent that the consumer cares about idiosyncratic characteristics. If, in addition, the consumer only cares about common characteristics (i.e., $\alpha = 1$), these two products are perfect substitutes. Because the $\mathbf{A}'\mathbf{A}$ matrix mechanically only has positive entries the resulting $\mathbf{\Sigma}$ matrix only has positive (off-diagonal) entries. Thus, our setup does not allow for complements which would be represented by negative off-diagonal elements in $\mathbf{A}'\mathbf{A}$ and $\mathbf{\Sigma}$.

[6] The idiosyncratic characteristics of our setup can be thought of as characteristics not observed by the econometrician. If $\alpha = 1$, the substitution patterns between products are perfectly tied down by the matrix of cosine similarities $\mathbf{A}'\mathbf{A}$ and its empirical equivalent provided by Hoberg and Phillips (2016) without any additional degree of freedom. $\alpha < 1$ provides an additional degree of freedom.

[7] We specify the exact ownership arrangements in Section 2.3.

The resulting demand and inverse demand functions are

$$\text{Aggregate demand}: \quad \mathbf{q} = (\mathbf{I}+\mathbf{\Sigma})^{-1}(\mathbf{b}-\mathbf{p}) \tag{2.8}$$

$$\text{Inverse demand}: \quad \mathbf{p} = \mathbf{b}-(\mathbf{I}+\mathbf{\Sigma})\,\mathbf{q} \tag{2.9}$$

2.2 Labor Demand and Product Supply

Each firm i produces output q_i by using labor h_i. The labor market clearing condition is given by $H = \sum_i h_i$. Because labor is the numéraire, the total cost of firm i is equal to the labor input h_i. We focus on the case where the cost function is quadratic because this setup yields closed-form solutions

$$h_i(q_i) = f_i + c_i^0 q_i + \frac{\delta_i}{2} q_i^2 \quad \text{thus} \quad c_i = c_i^0 + \delta_i q_i \tag{2.10}$$

where f_i and c_i are firm i's fixed and marginal costs and c_i^0 is the marginal cost intercept. We assume that fixed costs are sunk and paid in labor.

Each firm's production decision affects the prices of all the other products in the economy. Specifically, the derivative $\partial p_i/\partial q_j$ is proportional to the cosine similarity $\mathbf{a}_i'\mathbf{a}_j$. The more similar firms i and j are in terms of their product characteristics, the larger this derivative is in absolute value. Because of the symmetry of $\mathbf{A}'\mathbf{A}$, we have $\partial q_i/\partial p_j = \partial q_j/\partial p_i$.

The profits π_i of firm i are given by

$$\begin{aligned} \pi_i(\mathbf{q}) &= p_i(\mathbf{q}) \cdot q_i - h_i(\mathbf{q}) \\ &= q_i b_i - q_i^2 - \sum_{j\neq i} \sigma_{ij} q_i q_j - h_i. \end{aligned} \tag{2.11}$$

2.3 Ownership and Firm Objective Function

There are Z investment funds indexed by z through which the representative agent invests in the firms in the economy. V_z, the income of fund z, is the sum of the profits that the fund is entitled to based on its ownership shares

$$V_z \stackrel{\text{def}}{=} \sum_{i=1}^{n} s_{iz}\,\pi_i \qquad \text{and} \qquad \sum_{z=1}^{Z} s_{iz} = 1 \tag{2.12}$$

where s_{iz} is the proportion of shares of company i owned by fund z.[8] Following Rotemberg (1984), we assume that firm i maximizes ϕ_i, which is the sum of all investment funds' value functions,

[8] We assume that ownership allocations are exogenous as is standard in the literature. This assumption is further justified by recent theoretical work on endogenous ownership by Piccolo and Schneemeier (2020). They predict that, in the presence of noise traders and investment costs, common ownership will arise through investors' endogenous trading in a way that is unpredictable based on the structure of product markets (i.e., there are multiple equilibria with varying degrees of common ownership).

weighted by their respective ownership shares in firm i:

$$\phi_i \stackrel{\text{def}}{=} \sum_{z=1}^{Z} s_{iz} V_z = \sum_{z=1}^{Z} s_{iz} \sum_{j=1}^{n} s_{jz}\pi_j = \sum_{j=1}^{n} \pi_j \sum_{z=1}^{Z} s_{iz}s_{jz}. \tag{2.13}$$

We rewrite the right-hand side as a weighted sum of all firms' profits by substituting V_z from equation (2.12).

Define the common ownership weights κ_{ij} as

$$\kappa_{ij} \stackrel{\text{def}}{=} \frac{\mathbf{s}_i'\mathbf{s}_j}{\mathbf{s}_i'\mathbf{s}_i} \tag{2.14}$$

where

$$\mathbf{s}_i \stackrel{\text{def}}{=} \begin{bmatrix} s_{i1} & s_{i2} & \dots & s_{iZ} \end{bmatrix}' \tag{2.15}$$

This allows us to rewrite firm i's objective function[9] as

$$\phi_i \propto \pi_i + \sum_{j \neq i} \kappa_{ij}\pi_j. \tag{2.16}$$

We interpret κ_{ij} as the weight—due to common ownership by investment funds—that each firm i's objective function assigns to the profits of other firms relative to its own profits. It corresponds to what Edgeworth (1881) termed the "coefficient of effective sympathy among firms." This objective function also nests standard Cournot competition ($\kappa_{ij} = 0$ for $i \neq j$) and (multi-product) monopoly ($\kappa_{ij} = 1$ for $i \neq j$) as its limit cases. The $n \times n$ matrix $\mathbf{K}$ contains the bilateral common ownership weights for all the firms in the entire economy where all κ_{ii} entries are equal to 1.

The firms engage in Cournot competition. We assume that the firms' profit functions are concave. To maximize ϕ_i, firm i sets the following derivative with respect to q_i equal to zero:

$$\frac{\partial \phi_i}{\partial q_i} = \frac{\partial \pi_i}{\partial q_i} + \sum_{j \neq i} \kappa_{ij} \frac{\partial \pi_j}{\partial q_i}. \tag{2.17}$$

In line with much of the common ownership literature, we focus on unilateral effects (Ivaldi, Jullien, Rey, Seabright and Tirole, 2003b) and do not consider coordinated effects (Ivaldi, Jullien, Rey, Seabright and Tirole, 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.

At this point it is worth discussing our assumption that firm i (or 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

[9]Our notation for the firm's objective function follows Backus et al. (2021b) and Antón et al. (2023b). López and Vives (2019) and Azar and Vives (2021a) use the same structure but denote κ_{ij} by λ_{ij}.

(1984). Second, more recently, the common ownership literature has used the same objective function for firms as in equation (2.16) with Azar (2020) providing microeconomic foundations for the firm manager's maximization choice.

However, this assumption that firms 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.[10] 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 which directly benefits them.

In contrast, in our model firms only internalize all effects on investors' portfolio profits but ignore the impact (of the production 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 (2023) 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: corporate managers and consumer-workers. The strategic decisions of each firm i are in the hands of a corporate manager (also indexed by i). We assume that the manager's compensation ω_i depends on investment funds' portfolio profits and is equal to

$$\omega_i = \varepsilon \sum_{z=1}^{Z} s_{iz} V_z \tag{2.18}$$

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)[11] 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

[10] 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.

[11] This setup is reminiscent of Veblen (1899) because these agents engage in (conspicuous) consumption that is distinct from the basket of goods consumed by the representative worker-consumer.

condition for the production of good 0

$$\sum_{i=1}^{I} q_{i0} = h_0 \tag{2.19}$$

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

2.4 Equilibrium, Market Structure, and Ownership Counterfactuals

We estimate our theoretical model to analyze how total surplus, profits, and consumer surplus depend on market structure, ownership allocations, and firm conduct. 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 and which yields the *Cournot Common Ownership* (CCO) allocation $\mathbf{q}^{\phi}$. For this baseline scenario we assume an interior solution motivated by the fact that in the observed allocation all firms produce strictly positive output. For the counterfactual scenarios we maximize the potential functions outlined below subject to a non-negativity constraint.

We obtain the *Cournot Common Ownership* allocation $\mathbf{q}^{\phi}$ by solving the system of first order conditions given by

$$\mathbf{0} \;=\; \left(\mathbf{b} - \mathbf{c}^0\right) - \left(2\mathbf{I} + \boldsymbol{\Delta} + \boldsymbol{\Sigma} + \mathbf{K} \circ \boldsymbol{\Sigma}\right)\mathbf{q} \tag{2.20}$$

where $\boldsymbol{\Delta}$ is the matrix capturing firm-specific economies of scale. Its diagonal entries are the slopes of the firms' marginal cost functions denoted by δ_i in equation (2.10) and all its off-diagonal entries are equal to zero. $\boldsymbol{\Sigma}$ 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 (entry-by-entry) product. $\mathbf{b}$ and $\mathbf{c}^0$ are the demand and supply function intercepts. Under the assumption that the matrix $(2\mathbf{I} + \boldsymbol{\Delta} + \boldsymbol{\Sigma} + \mathbf{K} \circ \boldsymbol{\Sigma})$ is invertible, the *Cournot Common Ownership* allocation $\mathbf{q}^{\phi}$ is given by

$$\mathbf{q}^{\phi} \;=\; \left(2\mathbf{I} + \boldsymbol{\Delta} + \boldsymbol{\Sigma} + \mathbf{K} \circ \boldsymbol{\Sigma}\right)^{-1}\left(\mathbf{b} - \mathbf{c}^0\right). \tag{2.21}$$

We can now consider counterfactual scenarios in which firms make production decisions with alternative objective functions. For example, rather than maximizing portfolio profits ϕ_i firms maximize their own individual firm profits π_i as under standard Cournot competition. Each of these counterfactuals, summarized in the set of equations in (2.22), is the maximizer of a specific potential function.

Given our setup, we can implicitly define a *linear-quadratic network game* (Ballester et al., 2006) in which the vector of quantities $\mathbf{q}$ is taken as a strategy profile and the profit vector is taken as the payoff function. Loosely speaking, this is because the combination of the matrices $\boldsymbol{\Sigma}$ (the network of product market rivalry relationships based on the firms' product substitutabilities) 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 are part of a larger class of games known as "potential games" (Monderer and Shapley, 1996) because they are characterized by a scalar function called the game's *potential*.

Let us define the following three potential functions corresponding to *Aggregate Profit* $\Pi(\mathbf{q})$, *Cournot* $\Psi(\mathbf{q})$, and *Total Surplus* $W(\mathbf{q})$. These potential functions capture different assumptions about how firms behave and are inversely ranked by their level of competitiveness.

$$\begin{aligned}
\text{Aggregate Profit :} \quad & \Pi(\mathbf{q}) = \mathbf{q}'\left(\mathbf{b}-\mathbf{c}^0\right) - \frac{1}{2}\mathbf{q}'\left(2\mathbf{I}+\boldsymbol{\Delta}+2\boldsymbol{\Sigma}\right)\mathbf{q} - F \\
\text{Cournot Potential :} \quad & \Psi(\mathbf{q}) = \mathbf{q}'\left(\mathbf{b}-\mathbf{c}^0\right) - \frac{1}{2}\mathbf{q}'\left(2\mathbf{I}+\boldsymbol{\Delta}+\boldsymbol{\Sigma}\right)\mathbf{q} - F \qquad (2.22)\\
\text{Total Surplus :} \quad & W(\mathbf{q}) = \mathbf{q}'\left(\mathbf{b}-\mathbf{c}^0\right) - \frac{1}{2}\mathbf{q}'\left(\mathbf{I}+\boldsymbol{\Delta}+\boldsymbol{\Sigma}\right)\mathbf{q} - F
\end{aligned}$$

where $F \overset{\text{def}}{=} \sum_i^n f_i$.

Under the assumption that the matrices in the quadratic terms are positive definite, we maximize each of the potential functions in (2.22) to obtain the equilibrium allocations $\mathbf{q}$ that result under three alternative models of firm behavior. The least competitive allocation is *Monopoly*. In this setting a single investment fund controls the quantity decisions of all firms in the economy and jointly maximizes the firms' aggregate profits. The derivation of these potential functions (including the proof that its maximizers are the equilibria under different assumptions of firm behavior) appear in Pellegrino (2019).

Definition 1. The *Monopoly* allocation $\mathbf{q}^\Pi$ is defined as the maximizer of the aggregate profit function $\Pi(\mathbf{q})$:

$$\mathbf{q}^\Pi \overset{\text{def}}{=} \arg\max_{\mathbf{q}\geq\mathbf{0}} \Pi(\mathbf{q}) = \left(2\mathbf{I}+\boldsymbol{\Delta}+2\boldsymbol{\Sigma}\right)^{-1}\left(\mathbf{b}-\mathbf{c}^0\right) \quad \text{if interior solution} \qquad (2.23)$$

This allocation is the limit of a Cournot equilibrium with common ownership in which all of the profit weights tend to one (i.e., $\kappa_{ij} \to 1$).

Under standard *Cournot* competition there are no common ownership effects. Each firm i maximizes π_i without any regard for the profit impact of its production decisions on other firms because there is no overlap in the shareholdings of investment funds across firms.

Definition 2. The *Cournot* allocation $\mathbf{q}^\Psi$ is defined as the maximizer of $\Psi(\mathbf{q})$ where all profit weights κ_{ij} in $\mathbf{K}$ are equal to 0 for $i \neq j$:

$$\mathbf{q}^\Psi \overset{\text{def}}{=} \arg\max_{\mathbf{q}\geq\mathbf{0}} \Psi(\mathbf{q}) = \left(2\mathbf{I}+\boldsymbol{\Delta}+\boldsymbol{\Sigma}\right)^{-1}\left(\mathbf{b}-\mathbf{c}^0\right) \quad \text{if interior solution} \qquad (2.24)$$

Finally, in the *Perfect Competition* scenario firms behave as if they are atomistic producers pricing all units at marginal cost. This maximizes total (and also consumer) surplus.

Definition 3. The *Perfect Competition* allocation $\mathbf{q}^W$ is defined as the maximizer of the aggregate total surplus function $W(\mathbf{q})$:

$$\mathbf{q}^W \overset{\text{def}}{=} \arg\max_{\mathbf{q}\geq\mathbf{0}} W(\mathbf{q}) = (\mathbf{I}+\mathbf{\Delta}+\mathbf{\Sigma})^{-1}\left(\mathbf{b}-\mathbf{c}^0\right) \quad \text{if interior solution} \tag{2.25}$$

3 Data, Identification, and Validation

To estimate the model presented in Section 2 we need to map the various theoretical concepts to observed and identified variables and parameters. Table 1 documents how the variables in our model correspond to data, including the sources of these data.

3.1 Cost Function

In the baseline model we assume that the marginal cost slope all firms δ_i is equal to zero. Each firm therefore faces an exogenous constant marginal cost $c_i = c_i^0$, but this marginal cost differs across firms. The constant returns to scale assumption is common in many empirical industrial organization studies including Berry, Levinsohn and Pakes (1995), Nevo (2001), and Goeree (2008). We relax this assumption in Section B.1 where we allow for positive δ_i and thus decreasing returns to scale.

3.2 Firm Financials

We measure revenues ($p_i q_i$), variable costs (TVC_i), and fixed costs (f_i) in our model by using data from Compustat. These variables correspond to accounting revenues, Costs of Goods Sold (COGS), and Selling General and Administrative (SGA) costs, respectively. We follow De Loecker et al. (2020) in excluding firms with negative revenues or costs of goods sold, or negative gross margin (revenues less COGS). By definition, we have $\pi_i = p_i q_i - \text{TVC}_i - f_i$ which allows us to observe firm profits.

3.3 Text-Based Product Similarity

The matrix of product similarities $\mathbf{A}'\mathbf{A}$ is one of two crucial network inputs that are required to estimate our model. Hoberg and Phillips (2016, henceforth HP) provide an empirical estimate of this input. They compute time-varying product cosine similarities for firms in Compustat by analyzing the text of the firms' 10-K forms. Every 10-K form contains a *business description* section, which is the target of the algorithm devised by HP. HP construct a vocabulary of 61,146

Table 1: Variable Definitions and Mapping to Data

Panel A: Observed Variables

Notation	Description	Measurement	Source
$p_i q_i$	Revenues	Revenues	Compustat
TVC_i	Total Variable Costs	Costs of Goods Sold	Compustat
f_i	Fixed Costs	Selling, General and Administrative Costs	Compustat
$\mathbf{a}_i'\mathbf{a}_j$	Product Cosine Similarity	Word frequencies in 10-K Business Description	Hoberg and Phillips (2016)
$\mathbf{s}_i$	Ownership	Number of shares divided by total shares outstanding	SEC 13(f) filings, Compustat

Panel B: Identified Variables and Parameters

Notation	Description	Identification
δ_i	Marginal Cost Slope	$= 0$ in baseline model
α	Utility Weight on Common Characteristics	$= 0.12$ using Nevo (2001) as in Pellegrino (2019)
q_i	Output	$\mathbf{q}$ such that $\pi + \mathbf{f} = \mathrm{diag}\left(\mathbf{q}\right)\left(\mathbf{I} + \frac{1}{2}\boldsymbol{\Delta} + \mathbf{K} \circ \boldsymbol{\Sigma}\right)\mathbf{q}$
c_i^0	Marginal Cost Intercept	$= \frac{h_i}{q_i} - \frac{1}{2}\delta_i q_i$
$(\mathbf{I} + \boldsymbol{\Sigma})$	$\partial \mathbf{p} / \partial \mathbf{q}$	$= (1-\alpha)\,\mathbf{I} + \alpha \mathbf{A}'\mathbf{A}$
$\mathbf{b}$	Demand Intercept	$= (2\mathbf{I} + \boldsymbol{\Delta} + \boldsymbol{\Sigma} + \mathbf{K} \circ \boldsymbol{\Sigma})\,\mathbf{q} + \mathbf{c}^0$

words that firms use when describing their products, and that identify product characteristics.[12] For each firm i, HP use this vocabulary to construct a vector of word occurrences $\mathbf{v}_i$:

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

HP normalize this vector by dividing by the Euclidean norm which yields the empirical counterpart of $\mathbf{a}_i$

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

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, this matrix is the exact empirical counterpart to $\mathbf{A}'\mathbf{A}$—the matrix of cross-price effects in our theoretical model. Because each U.S. publicly listed firm must file a 10-K form the matrix of estimated product similarities provides a singularly comprehensive description of competitive interactions. It also covers the near entirety (97.8%) of the CRSP-Compustat universe.[13]

3.4 Ownership Data

Constructing detailed ownership 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 which we cover in the present paper. In order to calculate the matrix of common ownership profit

[12] Hoberg and Phillips (2016) describe their methodology in the following way: "*In our main specification, we limit attention to nouns (defined by Webster.com) and proper nouns that appear in no more than 25 percent of all product descriptions in order to avoid common words. We define proper nouns as words that appear with the first letter capitalized at least 90 percent of the time in our sample of 10-Ks. We also omit common words that are used by more than 25 percent of all firms, and we omit geographical words including country and state names, as well as the names of the top 50 cities in the United States and in the world.*"

[13] One of HP's objectives in developing their 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 of *production processes*, rather than of product characteristics. In other words, they are appropriate for estimating production functions, but unsuitable for proxying for the elasticity of substitution between different products.

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 from 1995 to 2021. For the years 1999 to 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 use equation (2.14) to compute the matrix of profit weights $\mathbf{K}$.

We use a statistical correction to account for the presence of unobserved investors without which we would obtain a thick right tail of implausibly large κ_{ij}. To do so, we first rewrite κ_{ij} as

$$\kappa_{ij} \;=\; \frac{\mathbf{s}_i'\mathbf{s}_j}{\mathrm{IHHI}_i} \tag{3.4}$$

where $\mathrm{IHHI}_i = \sum_{z=1}^{Z} s_{iz}^2$ is the investor Herfindahl concentration index. Denote the set of observed and of unobserved investors by O and $\mathcal{U}$, respectively. The denominator of the vector $\mathbf{s}_i$, which is the total number of shares, includes both observed and unobserved investors because it is taken from Compustat. Hence, typically, the observed s_{iz} will sum to a value less than one. All the diagonal 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 we have

$$\sum_{z\in\mathcal{U}} s_{iz}s_{jz} = 0. \tag{3.5}$$

Thus, 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

$$\widehat{\mathrm{IHHI}}_i \;=\; \sum_{k\in\mathcal{O}} s_{iz}^2 \tag{3.6}$$

which is a downwardly 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

$$\mathrm{IHHI}_i^* \;=\; \sum_{z\in\mathcal{O}} s_{iz}^2 + \sum_{z\in\mathcal{U}} s_{iz}^2. \tag{3.7}$$

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

$$S_{i(\mathcal{O})} = \sum_{z\in\mathcal{O}} s_{iz} \qquad S_{i(\mathcal{U})} = \sum_{z\in\mathcal{U}} s_{iz} \tag{3.8}$$

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

$$s_{i(\mathcal{O})z} = \frac{1}{S_{i(\mathcal{O})}} \cdot \sum_{z\in\mathcal{O}} s_{iz} \qquad s_{i(\mathcal{U})z} = \frac{1}{S_{i(\mathcal{U})}} \cdot \sum_{z\in\mathcal{U}} s_{iz} \tag{3.9}$$

As a result, we have

$$\begin{aligned}
\text{IHHI}_i^* &= \sum_{z\in\mathcal{O}} \left(S_{i(\mathcal{O})} \cdot s_{i(\mathcal{O})k}\right)^2 + \sum_{z\in\mathcal{U}} \left(S_{i(\mathcal{U})} \cdot s_{i(\mathcal{U})k}\right)^2 \\
&= S_{i(\mathcal{O})}^2 \cdot \sum_{z\in\mathcal{O}} s_{i(\mathcal{O})k}^2 + S_{i(\mathcal{U})}^2 \cdot \sum_{z\in\mathcal{U}} s_{i(\mathcal{U})z}^2 \\
&= S_{i(\mathcal{O})}^2 \cdot \text{IHHI}_i^{\mathcal{O}} + S_{i(\mathcal{U})}^2 \cdot \text{IHHI}_i^{\mathcal{U}}
\end{aligned} \tag{3.10}$$

where we have rewritten the terms in summation as the Herfindahl index among *observed* and *unobserved* investors only. 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

$$S_{i(\mathcal{U})} = 1 - S_{i(\mathcal{O})} \tag{3.11}$$

the true Herfindahl index can be rewritten as

$$\begin{aligned}
\text{IHHI}_i^* &= \left[S_{i(\mathcal{O})}^2 + \left(1 - S_{i(\mathcal{O})}\right)^2\right] \cdot \text{IHHI}_i^{\mathcal{O}} \\
&= \left[S_{i(\mathcal{O})}^2 + \left(1 - S_{i(\mathcal{O})}\right)^2\right] \cdot \sum_{i\in\mathcal{O}} \left(\frac{1}{S_{i(\mathcal{O})}} s_i\right)^2 \\
&= \left[1 + \left(\frac{1 - S_{i(\mathcal{O})}}{S_{i(\mathcal{O})}}\right)^2\right] \cdot \widehat{\text{IHHI}}_i
\end{aligned} \tag{3.12}$$

where the term in square brackets is the correction we apply to our estimates of the denominator of κ_{ij}.

The fact that we correct the numerator upward while not correcting the numerator $(\mathbf{s}_i'\mathbf{s}_j)$ implies that our estimate of κ_{ij} provides a lower bound because including the unobserved investors in the summation can only increase the value of the numerator. This in turn implies that our estimates of the welfare impact of common ownership are, by construction, conservative.

Although we think that a more conservative estimate is preferable, there are also downsides. If 13(f) data coverage of institutional shareholdings improved or worsened over time (which is possible but hard to verify), there is a possibility that the downward bias in the numerator (which we chose to tolerate in order to be conservative) might have become smaller or larger over time. This could potentially bias the time trend of our estimates.

If we chose to correct *both* the numerator and the denominator, we would (mechanically) obtain a larger welfare impact from common ownership but also potentially a different trend. A similar derivation as the one we used for the denumerator leads to the following correction for the numerator

$$\left(\mathbf{s}_i'\mathbf{s}_j\right)^* = \left[1+\frac{(1-S_i)(1-S_j)}{S_iS_j}\right]\left(\mathbf{s}_i'\mathbf{s}_j\right)^{\mathcal{O}}. \tag{3.13}$$

3.5 Identification

The remaining variables of our model are unobserved. However, we now show that they are identified subject to knowing α and $\mathbf{\Delta}$.

To identify $\mathbf{q}$ we write the vector of firm profits π and fixed costs $\mathbf{f}$ in terms of the quantity vector $\mathbf{q}$ and the matrices $\mathbf{\Delta}$, $\mathbf{\Sigma}$, $\mathbf{K}$

$$\pi+\mathbf{f} = \operatorname{diag}(\mathbf{q})\left(\mathbf{I}+\frac{1}{2}\mathbf{\Delta}+\mathbf{K}\circ\mathbf{\Sigma}\right)\mathbf{q} \tag{3.14}$$

and then find the quantity vector $\mathbf{q}$ that satisfies this equation.

q_i in turn determines the vector of prices and the cost function intercepts:

$$p_i = \frac{p_iq_i}{q_i} \quad \text{and} \quad c_i^0 = \frac{\mathrm{TVC}_i}{q_i}-\frac{\delta_i}{2}q_i \tag{3.15}$$

Next we can obtain the demand intercepts b_i using equation (2.24)

$$\mathbf{b} = (2\mathbf{I}+\mathbf{\Delta}+\mathbf{\Sigma}+\mathbf{K}\circ\mathbf{\Sigma})\,\mathbf{q}+\mathbf{c}^0. \tag{3.16}$$

Pellegrino (2019) shows how to map the cosine similarities of (Hoberg and Phillips, 2016) to those of the GHL demand system: the mapping requires two assumptions.

Assumption 1. There are as many common characteristics as words: $\mathbf{v}_i$ and $\mathbf{a}_i$ are vectors in $\mathbb{R}^m$.

Assumption 2. For all i, the vectors $\mathbf{v}_i$ and $\mathbf{a}_i$ are collinear up to a permutation.

In other words, our setup assumes that word frequencies in 10-K product descriptions ($\mathbf{v}_i$) can proxy for product characteristics ($\mathbf{a}_i$). We empirically validate this assumption in Section 3.6. Note that we only map *common* characteristics to the vocabulary of Hoberg and Phillips (2016), while we assume that the idiosyncratic characteristics are *unobserved*. The addition of unobserved idiosyncratic characteristics adds a degree of freedom to the demand system, namely the parameter α, which scales the overall magnitude of the cross-price elasticities.

We next discuss the identification of the free parameter α, which controls the elasticity of substitution among products. Most industrial organization demand estimation studies (Berry et al., 1995; Nevo, 2001; Goeree, 2008) assume exogenous constant returns to scale (i.e., flat marginal cost), $c_i = c_i^0$ which is implied by $\delta_i = 0$ for all firms $i = 1, 2, ..., n$. For our baseline model we also adopt this assumption.

Pellegrino (2019) shows that, as long as the inverse cross-price elasticity of demand is observed for at least one firm pair, the parameter α can be identified as a closed-form expression of such an elasticity and other observables (revenues, costs and cosine similarities). In the GHL demand system the inverse cross-price demand elasticity ϵ_{ij} is given by

$$\epsilon_{ij} = \frac{\partial \log p_i}{\partial \log q_j} = -\frac{q_j}{p_i}\sigma_{ij}. \tag{3.17}$$

Furthermore, the parameter α must satisfy the equation

$$\alpha = -\frac{\epsilon_{ij} p_i q_j + \epsilon_{ji} p_j q_i}{2 \cos_{ij}^{\mathrm{HP}} \sqrt{p_i q_i - \mathrm{TVC}_i} \sqrt{p_j q_j - \mathrm{TVC}_j}} \tag{3.18}$$

where $\cos_{ij}^{\mathrm{HP}}$ is the HP cosine similarity between firm i and firm j. If we observe the inverse cross-price demand elasticity ϵ_{ij} of some specific firm pair (i, j) then all the variables on the right-hand side of the equation are observable and we can pin down α.

Following Pellegrino (2019), we use the inverse cross-price elasticity between Kellogg's and Quaker Oats from the seminal study of the ready-to-eat cereal industry by Nevo (2001). Using equation (3.18) we obtain $\alpha = 0.12$. This in turn allows us to pin down all the other parameters of our model.

3.6 Validation

In the previous subsection, we discussed the identifying assumptions that allow us to map the cosine similarity matrix. Next, we discuss the empirical evidence in support of these assumptions.

3.6.1 Clusters of the Product Similarity Network

The first level of validation demonstrates that there exists a close correspondence between the community structure of HP's network of product cosine similarities and an external identifier of broad product markets. This is shown graphically in the online appendix of Pellegrino (2019). He colors the nodes of a variant of Figure 1 (Panel A) according to the corresponding firms' GICS classifications and finds a near-perfect overlap between the color nodes and the visible network clusters. Importantly, the graph is created *without* targeting the GICS classifications.

While this exercise shows that HP's product similarity data performs remarkably well in detecting broad product markets, it is not a priori clear whether the GHL demand system using HP's cosine similarity data generates realistic demand elasticities. This requires a validation at a finer level.

TABLE 2: MICROECONOMETRIC ESTIMATES VS. GHL (PELLEGRINO, 2019)

Market	Firm i	Firm j	Demand Elasticity $\left(\frac{\partial q_i}{\partial p_j} \cdot \frac{p_j}{q_i}\right)$ Micro Estimate	GHL
Auto	Ford	Ford	-4.320	-5.197
Auto	Ford	General Motors	0.034	0.056
Auto	Ford	Toyota	0.007	0.017
Auto	General Motors	Ford	0.065	0.052
Auto	General Motors	General Motors	-6.433	-4.685
Auto	General Motors	Toyota	0.008	0.005
Auto	Toyota	Ford	0.018	0.025
Auto	Toyota	General Motors	0.008	0.008
Auto	Toyota	Toyota	-3.085	-4.851
Cereals	Kellogg's	Kellogg's	-3.231	-1.770
Cereals	Kellogg's	Quaker Oats	0.033	0.023
Cereals	Quaker Oats	Kellogg's	0.046	0.031
Cereals	Quaker Oats	Quaker Oats	-3.031	-1.941
Computers	Apple	Apple	-11.979	-8.945
Computers	Apple	Dell	0.018	0.025
Computers	Dell	Apple	0.027	0.047
Computers	Dell	Dell	-5.570	-5.110

3.6.2 Self-Reported Rivalries

The second level of validation is provided by (Hoberg and Phillips, 2016) in their seminal paper on cosine similarities. To validate their product similarity data, they use the fact that firms themselves identify their closest competitors in a separate section of the 10-K form.

HP show that their industry classification built using their product similarity database (TNIC) strongly outperforms traditional industry classifications (such as NAICS and SIC) in predicting product market rivalries.

3.6.3 Demand Estimates

While the two validation exercises presented above support the validity of HP's cosine similarity data as an *ordinal* gauge of product market overlap, in order to establish the validity of Assumptions 1 and 2 we also need to show that they contain *cardinal* information. In other words, we need to show that the magnitude of the resulting GHL elasticities can also be independently validated.

To this end, Pellegrino (2019) performs a third level of validation. He compares estimates of demand elasticities based on the implementation of GHL with those from landmark industrial organization studies on automobiles (Berry et al., 1995), ready-to-eat cereals (Nevo, 2001), and computers (Goeree, 2008), for firm pairs that can be found both in those studies as well as in Compustat.[14]

Table 2, reproduced from Pellegrino (2019), reports the results of this comparison. The signs of the GHL estimates are identical to those of the corresponding estimates from industrial organization studies for every single firm-firm pair. Furthermore, even though these demand elasticities are untargeted and the only free parameter for all years and for the entire economy is $\alpha = 0.12$, the GHL estimates also are similar to the magnitudes of the own and cross-price elasticities as a whole and for individual firm pairs.

4 Empirical Results

Having set up and validated our demand system and described firm behavior under various alternative competition scenarios we can now measure and evaluate the economy-wide impact of common ownership.

4.1 Product Similarity and Common Ownership

We first describe the salient features of our data on product similarity and common ownership by visualizing their respective network structures and the relationship between them.

4.1.1 Network Structure of Product Similarity and Common Ownership

Our oligopoly game is characterized by two networks: that of product similarities and that of common ownership. We first visualize the network structure of HP's product similarity dataset. We employ the widely-used network visualization algorithm of Fruchterman and Reingold (1991, henceforth FR) to reduce the network's dimensionality from 61,146 (the number of words in the HP's vocabulary) to two (a bidimensional surface). The FR algorithm models the network nodes as particles and arranges them on a plane. However, the algorithm is sensitive to the initial configuration of nodes and has difficulties visualizing the cluster structure of large networks. We address this well-known problem by pre-arranging the nodes with the OpenOrd algorithm (Martin, Brown, Klavans and Boyack, 2011) which was specifically developed for this purpose, before running the FR algorithm.

Every publicly traded firm in 2008, the mid-point of our sample period, is a dot in each of the two panels of Figure 1. In the left panel, firm pairs with a high cosine product similarity are shown closer and are connected by a thicker line. Two patterns are particularly noteworthy. First, firms

[14]The microeconometric estimates from IO studies are product-by-product. They are aggregated into firm-by-firm elasticities using a weighted average

Figure 1: Network Visualization

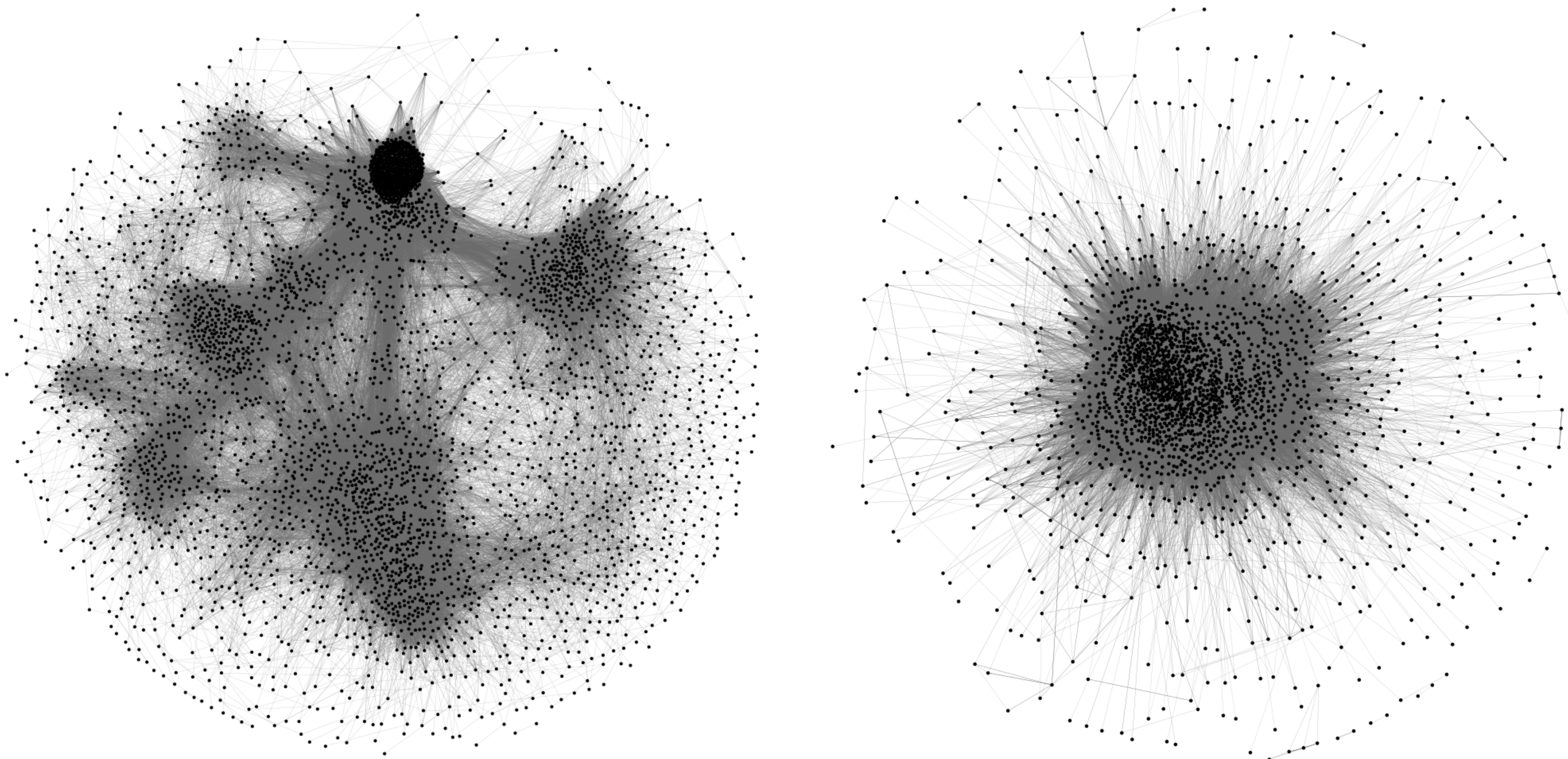

Figure Notes: The diagrams are two-dimensional representations of the network of product similarities (left panel), first computed by Hoberg and Phillips (2016), and of the network of ownership shares (right panel). The data include the universe of publicly listed firms in 2008. Firm pairs that are closer in product market space and closer in ownership space, are shown with thicker links. These distances are computed in spaces that have approximately 61,000 and 2,800 dimensions, respectively. We use the OpenOrd algorithm of Martin et al. (2011) and the FR gravity algorithm of Fruchterman and Reingold (1991) to plot these high-dimensional objects over a plane.

are unevenly distributed over the space of product characteristics. In some areas in the left panel of Figure 1 there is a significantly denser population of firms than in other areas. Second, the product similarity network exhibits a distinct community structure: large groups of firms cluster in the same 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 2,788 (the number of observed investors, not including any unobserved investors) to two using the OpenOrd and FR algorithms to visualize the network in the right panel of Figure 1. Firm pairs that have large ownership weights between them are shown closer and are connected by a thicker line. In contrast to the product similarity network depicted in Figure 1 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.

The two networks also evolve over time as shown in Figure 2. The ownership network is dramatically more connected in 2021 (bottom right) than in 1995 (top right), a trend documented in detail by Azar (2012) and Backus et al. (2021b). In contrast, the network of product similarities is somewhat more connected in 1995 (top left) than in 2021 (bottom left), a trend that is consistent with firms being more differentiated and more insulated from competition in the later part of the sample, as documented by Pellegrino (2019) and Ederer and Pellegrino (2023).

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 1995 and slightly increases to 0.0174 in 2021. In contrast, the average value of κ_{ij} is equal to 0.0021 in 1995 but rises almost sevenfold to 0.0146 in 2021.

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 the system of first order conditions in equation (2.20) 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 $\mathbf{q}^{\phi}$ differ from the standard benchmarks of standard Cournot without common ownership in equation (2.24) and monopoly in equation (2.23).

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 2021. 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

Figure 2: Network Evolution - Product Similarity and Ownership

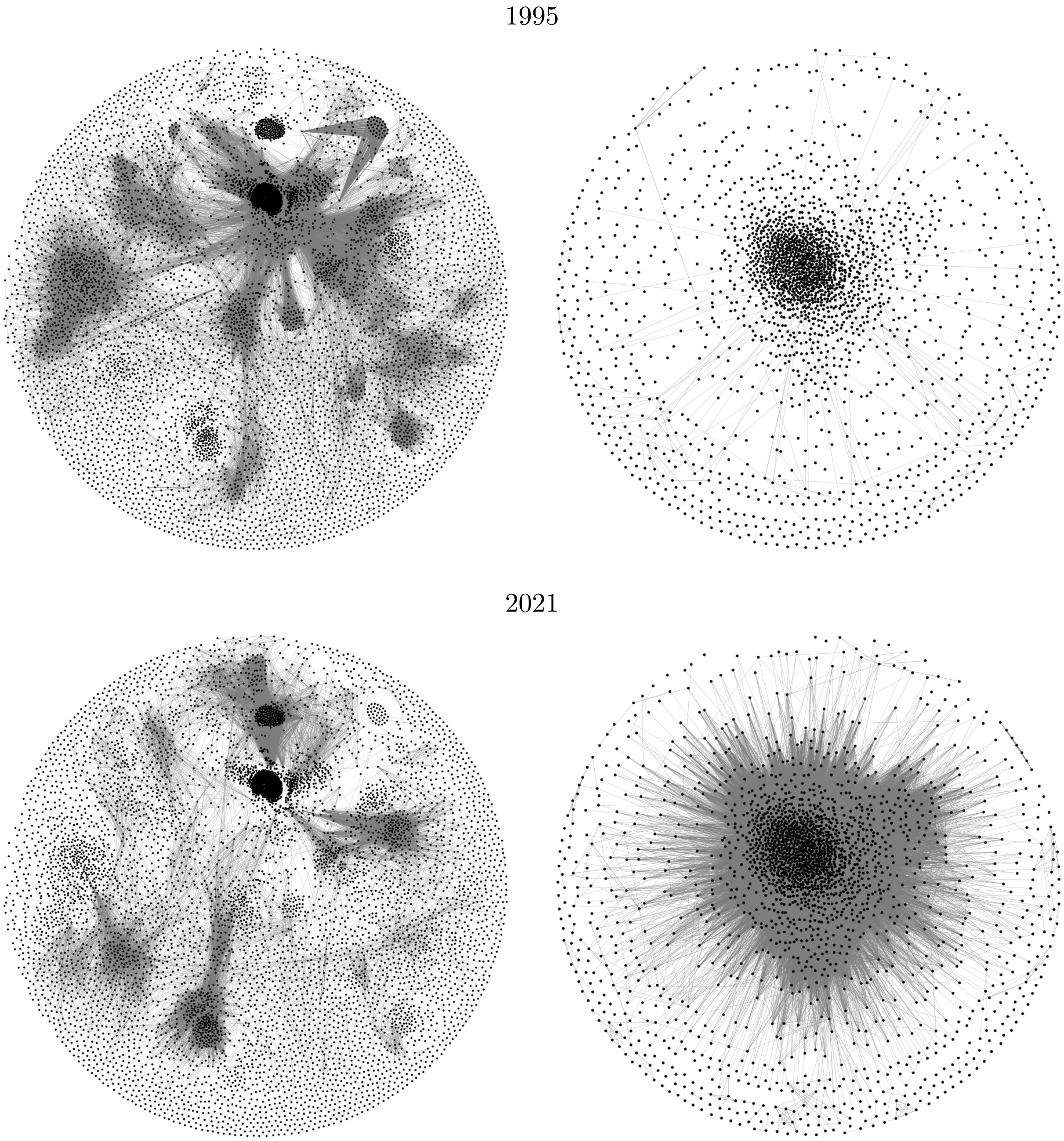

Figure Notes: The diagrams are two-dimensional representations of the network of product similarities (left panels) and the network of ownership shares (right panels) in 1995 (top panels) and 2021 (bottom panels). To ensure comparability we hold the position of firms on the graph of each type of network fixed which involves including firms that may not operate in that particular year. Firm pairs that are closer in product market space and ownership space are shown with thicker links. These distances are computed in spaces that have approximately 61,000 and 2,800 dimensions. We use the OpenOrd algorithm of Martin et al. (2011) and the FR gravity algorithm of Fruchterman and Reingold (1991) to plot these high-dimensional objects over a plane.

Figure 3: Product Similarity and Profit Weights (2021)

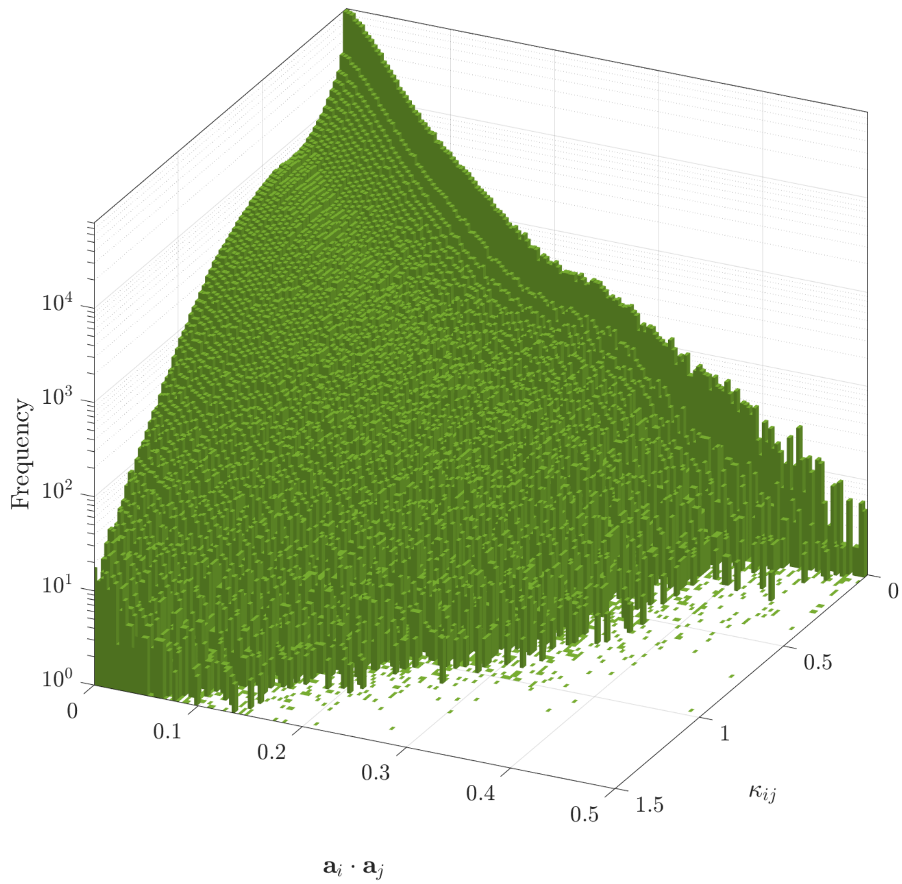

Figure Notes: The figure above is a histogram of the joint distribution of product similarity $\mathbf{a}_i \cdot \mathbf{a}_j$ and profit weights κ_{ij} for all firm ij pairs in 2021.

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. However, there is no clear relationship between product similarity and common ownership. The correlation and rank correlation coefficients for the two variables in 2021 are 0.0264 and 0.0296, respectively, which means that common ownership is not more pronounced for firms that are more similar in product space. This pattern is also apparent when overlaying the two networks as in Figure 4 which reveals the differences in cluster structure of the networks in 2021. The pink $\mathbf{K}$ network only has one big cluster whereas the blue $\mathbf{A}'\mathbf{A}$ network has multiple clusters that do not overlap in any particular way with the $\mathbf{K}$ network.

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

Figure 4: Combined Network Visualization

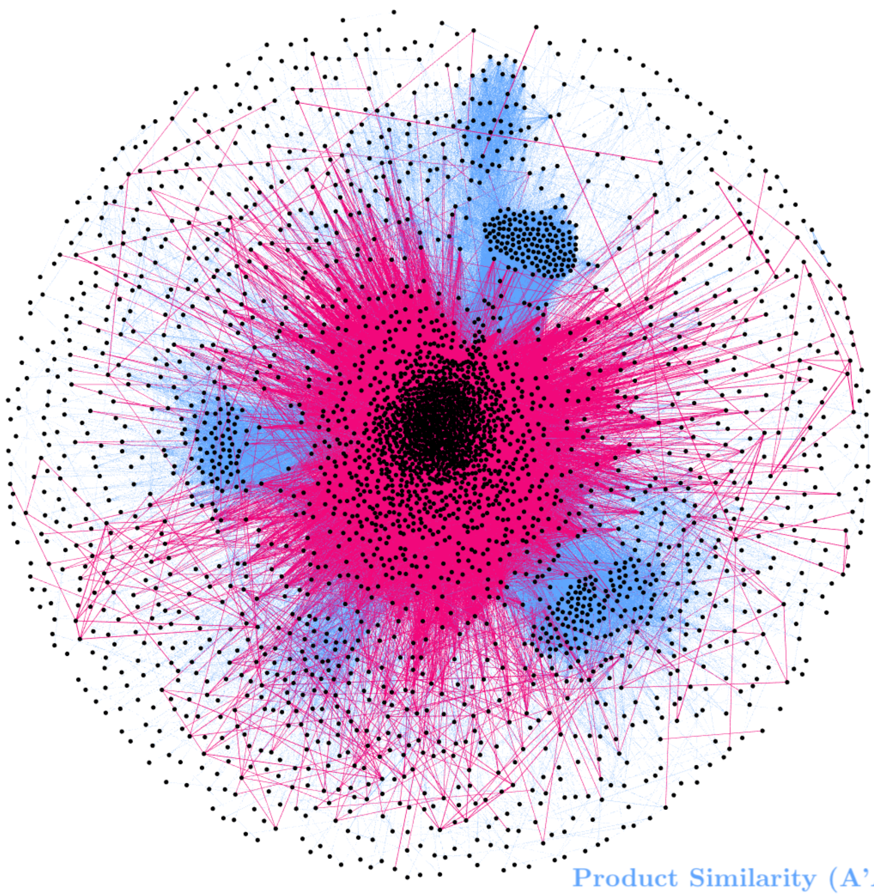

Figure Notes: The diagram is a two-dimensional representation of the networks of product similarities (blue) and of the network of ownership shares (pink). The data cover the universe of publicly listed firms in 2021. Firm pairs that are closer in product market space and closer in ownership space, are shown with thicker links. These distances are computed in spaces that have approximately 61,000 and 2,800 dimensions, respectively. We use the OpenOrd algorithm of Martin et al. (2011) and the FR gravity algorithm of Fruchterman and Reingold (1991) to plot these high-dimensional objects over a plane.

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, La Porta, Lopez-de Silanes and Shleifer, 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.

Table 3: Welfare Estimates (2021)

	Scenario	*Common Ownership*	*Cournot-Nash*	*Perfect Competition*	*Monopoly*
		(1)	(2)	(3)	(4)
Welfare Statistic	**Variable**	$\mathbf{q}^{\phi}$	$\mathbf{q}^{\Psi}$	$\mathbf{q}^{W}$	$\mathbf{q}^{\Pi}$
Total Surplus (US$ trillions)	$W(\mathbf{q})$	8.303	9.570	11.116	7.629
Aggregate Profits (US$ trillions)	$\Pi(\mathbf{q})$	3.300	2.167	0.000	4.141
Consumer Surplus (US$ trillions)	$\mathrm{CS}(\mathbf{q})$	5.003	7.402	11.116	3.488
Total Surplus / Perfect Competition	$\frac{W(\mathbf{q})}{W(\mathbf{q}^W)}$	0.747	0.861	1.000	0.686
Aggregate Profit / Total Surplus	$\frac{\Pi(\mathbf{q})}{W(\mathbf{q})}$	0.397	0.226	0.000	0.543
Consumer Surplus / Total Surplus	$\frac{\mathrm{CS}(\mathbf{q})}{W(\mathbf{q})}$	0.603	0.774	1.000	0.457

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.

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 (2.13).

We first compute total surplus and decompose it into profits and consumer surplus as reported in Table 3 for 2021, 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 A.1 in the appendix reports the same estimates for 1995, the first year of our sample.

In 2021, under *Common Ownership*, the aggregate economic profits of public firms is equal to \$3.300 trillion, consumers gain a surplus of \$5.003 trillion, and the estimated total surplus is equal to \$8.303 trillion. 39.7% of the total surplus produced accrues to companies in the form of oligopoly profits under common ownership while consumers appropriate a bigger share of 60.3% of total surplus.

The estimates for our two primary counterfactuals, *Cournot-Nash* and *Perfect Competition*, are reported in column 2 and 3. Comparing the estimates of these counterfactual models with those of the *Common Ownership* allocation in column 1 shows that the welfare costs of common ownership are substantial, but not as large as the welfare costs of oligopoly. First, total surplus is slightly higher at \$9.570 trillion under oligopoly without common ownership (Cournot-Nash) and substantially higher at \$11.116 trillion under perfect competition. Thus, we estimate that in 2021 the deadweight loss of oligopoly amounts to 13.9% of total surplus. On top of that, common ownership leads to an additional deadweight loss of 11.4% of the total surplus under perfect competition.

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 total surplus: \$11.116 trillion, about 50% more than in the *Cournot-Nash* allocation (\$7.402 trillion) and more than double than in the *Common Ownership* allocation (\$5.003 trillion). This is partly because when firms price at marginal cost and marginal costs are constant, 100% of the total surplus accrues to consumers and partly because the total surplus is greater due to allocative efficiency. In contrast, merely 77.4% and 60.3% of total surplus accrue to consumers under oligopoly without and with common ownership. Corporate profits, on the other hand, move in the opposite direction. The aggregate profits under common ownership (\$3.300 trillion) are about 50% larger than those under standard Cournot competition (\$2.167 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 \$1.267 trillion, but this welfare loss falls entirely on consumers. Common

Figure 5: Total Surplus of U.S. Public Firms

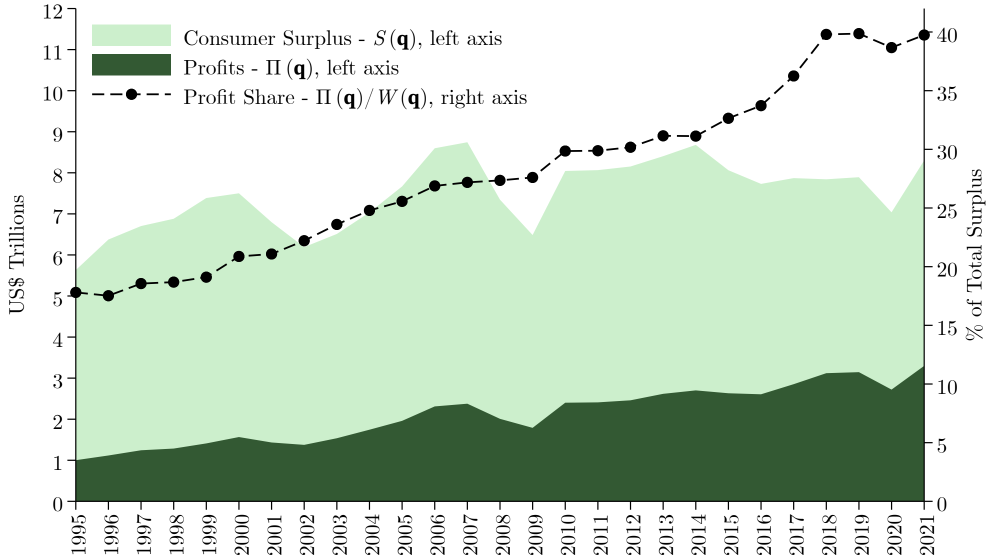

Figure Notes: The figure plots the evolution of aggregate (economic) profits $\Pi(\mathbf{q})$, aggregate consumer surplus $\mathrm{CS}(\mathbf{q})$, and total surplus $W(\mathbf{q})$ using the left axis. The right axis shows profits as a percentage of total surplus ($\Pi(\mathbf{q})/W(\mathbf{q})$, black dotted line).

ownership lowers consumer surplus by $2.399 trillion from $7.402 trillion to $5.003 trillion.

In contrast, common ownership raises aggregate profits by $1.133 trillion from $2.167 trillion to $3.300 trillion. This aggregate increase in corporate profits however obscures the fact that common ownership differentially affects corporate profits (net of fixed costs), as can be seen in Table A.2 in the appendix which lists the companies that experience the largest profit increases and decreases due to common ownership. This differential impact of common ownership occurs for several reasons. First, as documented in Figure 1 and Figure 3 there is a great deal of heterogeneity in common ownership. Second, the magnitude of the impact of common ownership depends on companies' position in the network of product market rivalry. Third, when common ownership increases, all firms produce less in the aggregate (raising profits overall), but there is also a reallocation of market shares towards more productive firms. For some unproductive firms the effect of reallocation on profits is negative and sufficiently strong to counteract the broad profit-increasing effects of common ownership. Thus, it is not surprising that some of the largest and most profitable firms in the U.S. economy benefit the most from common ownership relative to the uncoordinated Cournot oligopoly benchmark.

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 $7.629 trillion and thus significantly lower than in the common ownership equilibrium allocation. In contrast, aggregate corporate profits are higher at $4.141 trillion, but this does not

Figure 6: Profit Share of Total Surplus

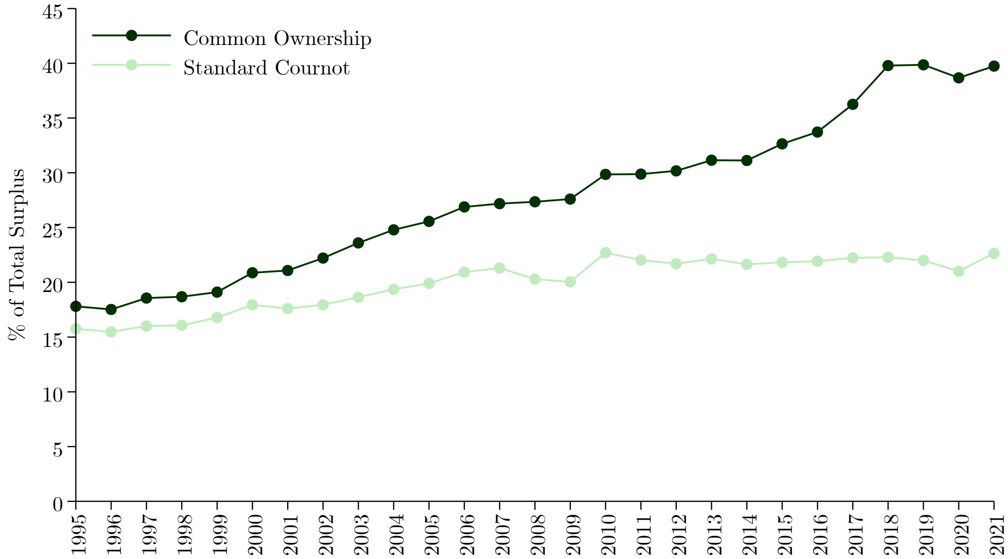

Figure Notes: The figure plots the profit share under standard Cournot (dark green line) and Cournot with common ownership (light green line) between 1995 and 2021.

outweigh the decrease in consumer surplus which falls to \$3.488 trillion equal to 45.7% of the total surplus.

The broad conclusion 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 next 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 rise of ownership concentration among publicly listed U.S. companies for the period from 1995 to 2021. Importantly, our analysis incorporates changes in the product offerings and ownership over time in our estimates by utilizing time-varying data on both product similarity and ownership.

In Figure 5, we plot annual aggregate consumer surplus $\mathrm{CS}(\mathbf{q})$ (dark green area) and profits $\Pi(\mathbf{q})$ (light green area) between 1995 and 2021 for the observed *Common Ownership* equilibrium. Total surplus W is the combined area of $\mathrm{CS}(\mathbf{q})$ and $\Pi(\mathbf{q})$. 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 increased between 1995 and 2021 from \$5.632 trillion to \$8.303 trillion. The increase over this time period is due to the increase in aggregate profits and the consumer surplus created by these firms. Profits increased from \$1.003 trillion to

\$3.300 trillion and consumer surplus increased from \$4.629 trillion in 1995 to \$5.003 trillion in 2021. However, because the relative increase in profits was much larger than the increase in consumer surplus, the profit share increased from 17.8% of total surplus in 1995 to 39.7% in 2021.

Pellegrino (2019) shows that at the firm level there is a monotonic relationship between the profit share of the surplus generated by firm i and a metric of (inverse) product market centrality which is a generalized eigenvalue of the equation determining the oligopolistic (Cournot or Cournot with Common Ownership) equilibrium. The aggregate profit share can therefore be interpreted as an average measure of centrality for the product market network (without common ownership) and for the combination of both networks. Hence the relative time trends in Figure 5 further illustrate the increase in aggregate concentration in both networks which is particularly pronounced for the ownership network and less drastic for the product market network.[15]

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 6. Under standard Cournot without common ownership (dark green line) the increase in the profit share is significantly less pronounced than under Cournot with common ownership (light green line). Under standard Cournot the profit share increases by roughly 7 percentage points from 15.8% to 22.6%. In contrast, the increase in the profit share under common ownership is more than twice as large. The profit share increases by more than 20 percentage points from 17.8% to 39.7%.

Figure 7 plots the respective percentage gains in total surplus when the economy moves from the standard Cournot equilibrium $\mathbf{q}^{\Psi}$ and from the CCO equilibrium $\mathbf{q}^{\phi}$ to the first-best perfect competition equilibrium $\mathbf{q}^{W}$. These are the deadweight losses of oligopoly (dark green line) and of the combination of oligopoly and common ownership (light green line). Their respective trends mimic those of the profit shares of total surplus under both of these regimes. The deadweight losses increase from 8.0% and 9.3% in 1995 to 13.9% and 25.3% in 2021 suggesting increasingly harmful effects of oligopolistic behavior and common ownership.

The primary focus of our paper is the quantification of the welfare impact of common ownership over and above the impact of oligopoly. The left panel of Figure 8 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 7. 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 1995 (1.4% of total surplus), it increases about ninefold over the course of our sample reaching 13.2% of total surplus in 2021. As a result, the increase in deadweight loss under Cournot with common ownership (Figure 7, light green line) from 9.3% in 1995 to 25.3% in 2021 is due in a much larger part to common ownership than to

[15]Section B.4 in the appendix provides additional information on the evolution of product market centrality over time.

Figure 7: Deadweight Loss

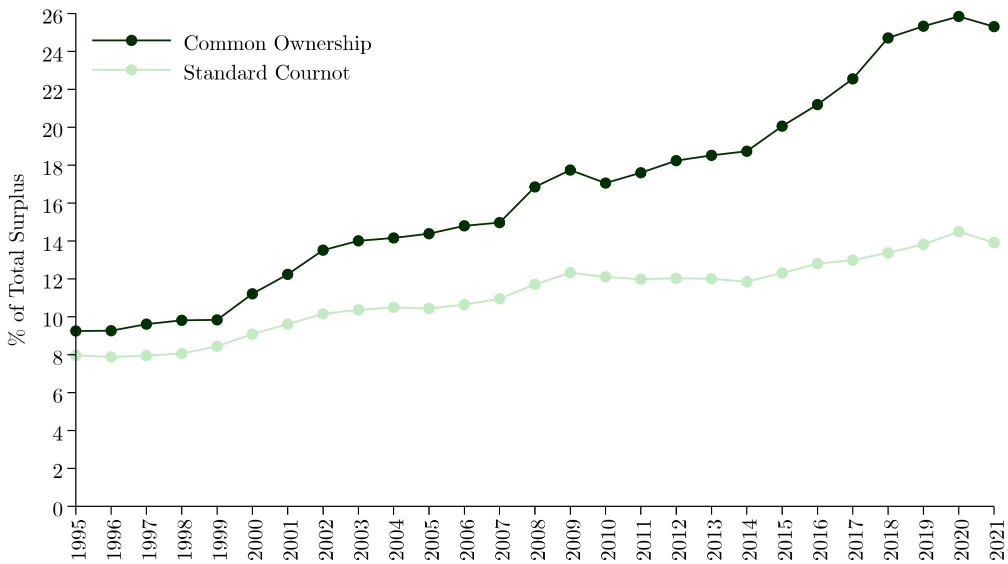

Figure Notes: The figure plots the estimated deadweight loss (DWL) of oligopoly and of oligopoly and common ownership, between 1995 and 2021. The dark green line is the DWL of oligopoly, the % difference in total surplus between the Cournot equilibrium and the Perfect Competition scenario. The light green line is the % difference between the Cournot Common Ownership equilibrium and the Perfect Competition scenario.

Figure 8: Common Ownership: Deadweight Loss and Distributional Effects

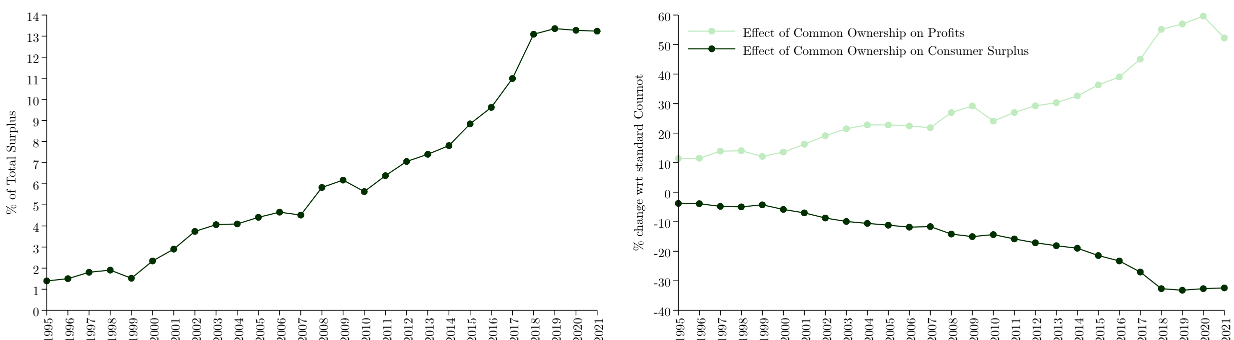

Figure Notes: The left panel of the figure above plots the deadweight loss from common ownership, measured as the difference in total surplus (W) between the Cournot oligopoly allocation and the CCO allocation. The right panel displays the effect of common ownership on profits and consumer surplus, measured as the percentage difference between the Cournot oligopoly allocation and the CCO allocation from 1995 to 2021.

standard oligopoly reasons such as increased concentration or greater product differentiation.

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 8 we plot the effect of common ownership on corporate profits and consumer surplus from 1995 to 2021. Common ownership raised corporate profits by 11.4% in 1995 and by 52.2% in 2021. At the same time, it lowered consumer surplus by 3.8% in 1995 but by 32.4% in 2021. Although the percentage reduction in consumer surplus is smaller in magnitude than the corresponding increase in profits, there is still a substantial deadweight loss because corporate profits constitute less than a fifth of total surplus in 1995 and only slightly more than a third in 2021. Moreover, profits would constitute a markedly smaller share of surplus in the absence of common ownership as shown in Figure 6.

Taken together, our results suggest that, compared to 1995, U.S. public firms have more market power in 2021 due to standard oligopolistic reasons and, more importantly, 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 Corporate Governance under Common Ownership

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 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

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

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., $\gamma_{iz} \stackrel{\text{def}}{=} \sqrt{s_{iz}}$).

5.2 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 who 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").

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

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

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

5.3 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 may attenuate or even exacerbate the anticompetitive effects of common ownership (Antón et al., 2023b). Similarly, Gilje et al. (2020, henceforth GGL) have highlighted the importance of investor inattention in evaluating the effects 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:

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

Although 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

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

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 such that sympathy score is given by

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

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.

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

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

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 corporate 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, $0 \leq \bar{\kappa}_{ij} \leq \kappa_{ij}$. Therefore, in the framework of GGL, investor inattention dampens the product market effects of common ownership.

One frequent criticism of the common ownership literature is that because many of the largest common owners are passive investors (i.e., investors who follow a passive investing strategy), they cannot and do not affect firm decisions. Appel, Gormley and Keim (2016) empirically investigate whether such passive investors are in fact passive owners (i.e., owners who do not influence firms' governance). Their analysis suggests that this is a misconception: passive mutual funds play a rather active role in firms' governance choices and thus passive investing does not necessarily equate with passive ownership.[16] Therefore, in our analysis we do not specifically distinguish between active and passive investors.

5.4 Governance Frictions and Managerial Entrenchment

Our baseline governance model assumes that when setting q_i the manager of firm i maximizes the profit shares of the firm's investors, weighting them in proportion to the stake they own. However, in reality the incentives of corporate managers and shareholders are not perfectly aligned because of governance frictions and managerial entrenchment. Azar and Ribeiro (2022, henceforth AR) develop a flexible objective function that allows for partial managerial entrenchment in which the manager i's objective function is given by

$$\phi \propto \pi + \tau_i \sum_{j \neq i} \kappa_{ij} \pi_j \tag{5.9}$$

[16]Furthermore, as Antón et al. (2023b) show both theoretically and empirically, the relative governance passivity of common owners does not imply that there are no anticompetitive product market effects of common ownership.

The mitigation factor τ_i is equal to

$$\tau_i = \frac{\gamma\psi \mathrm{IHHI}_i}{1+\gamma\psi \mathrm{IHHI}_i} \tag{5.10}$$

where $\mathrm{IHHI}_i = \sum_{z=1}^{Z} s_{iz}^2$ is the investor Herfindahl concentration index. As is apparent from the equation, the mitigation factor is larger when the cost to managers of shareholder dissent γ is higher, the responsiveness of shareholders to managerial behavior ψ is higher, and when shareholder concentration IHHI_i is higher. τ_i lies between 0 and 1 and thus spans the extreme cases of no internalization ($\tau_i = 0$) and full internalization ($\tau = 1$) and all the partial internalization cases in between.

We consider two specifications highlighted by Azar and Ribeiro (2022). First, we estimate our model with a mitigation factor $\tau = 0.29$ that is constant across firms and does not depend on the concentration of shareholder ownership within each firm. Second, we use the best-fitting structural AR specification in which the mitigation factor varies across firms and across time and is given by

$$\tau_i = \frac{\exp\left[\theta_0 + \log\left(\mathrm{IHHI}_i\right)\right]}{1+\exp\left[\theta_0 + \log\left(\mathrm{IHHI}_i\right)\right]} \tag{5.11}$$

and $\theta_0 = \log(\gamma\psi) = 2.6844$ which also yields the median mitigation factor equal to 0.29 that we use for our uniform specification.

5.5 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 9 we plot the evolution of the deadweight loss that is due to the presence of common ownership under different governance assumptions. Whereas superproportional influence of large investors leads to a deadweight loss that is quite similar though slightly larger than under proportional common ownership throughout our sample, the effect of common ownership with blockholder thresholds is much smaller in the early years of our sample. Until 2013 the deadweight loss of blockholder common ownership is well below 0.5% of total surplus. However, after that it rises rapidly to as high as 9% 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, Heemskerk and Garcia-Bernardo, 2017).

The deadweight loss estimates of common ownership under the GGL inattention model hover at around 1% of total surplus at the beginning of our sample. The estimates then increase in tandem with proportional influence models, though at a slower pace. Even under GGL inattention,

Figure 9: Common Ownership DWL - Alternative Governance Models

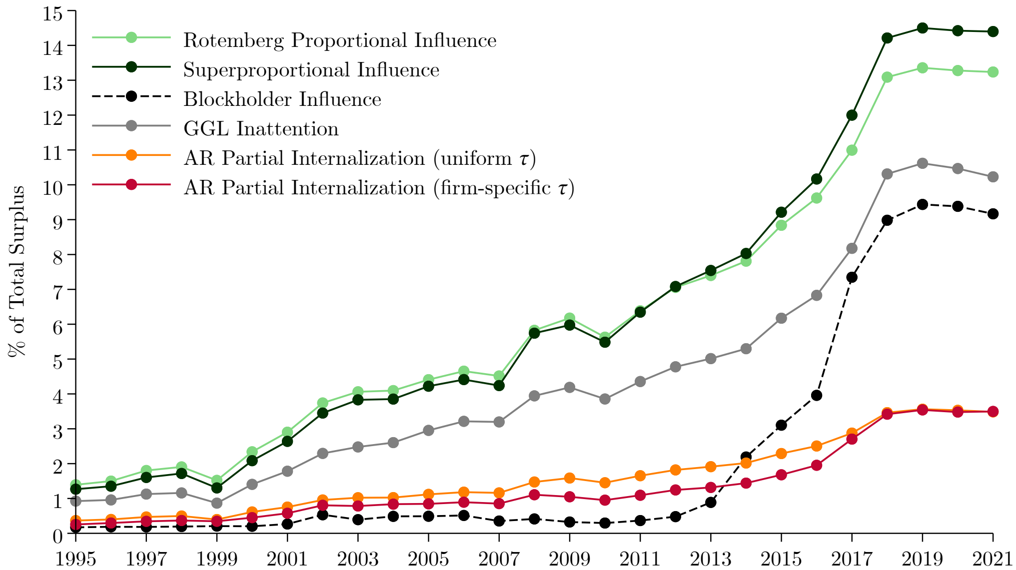

Figure Notes: The figure plots the deadweight loss of common ownership, computed as % of the total surplus, under proportional, superproportional and blockholder influence models, the GGL inattention model, and the AR partial internalization models from 1995 to 2021.

common ownership leads to a deadweight loss of about 10% of total surplus, much higher than in 1995. 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.

Finally, perhaps the most realistic model of corporate governance under common ownership is the AR partial internalization model with uniform or firm-specific mitigation parameters. The estimated deadweight loss of common ownership using either of these models is small and quite similar, though slightly higher, to the blockholder influence model at the beginning of the sample. However, it does not rise nearly as dramatically. Using both uniform and firm-specific mitigation parameters we find that the estimated deadweight loss of common ownership is approximately 3.5%.

In Figure 10 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 30% of total surplus and lowers consumer surplus by almost 24% in 2021. Under GGL governance assumptions

Figure 10: Distributional Effects - Alternative Governance Models

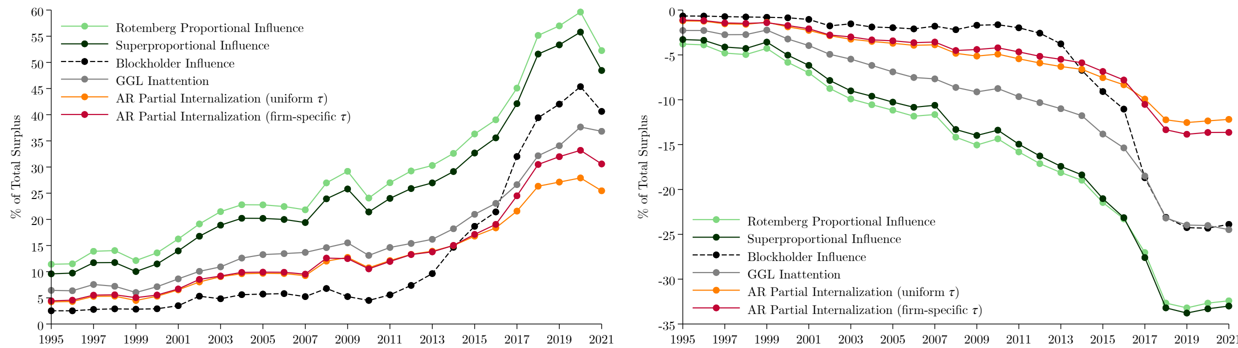

Figure Notes: The figure shows the effect of common ownership on profits (left panel) and consumer surplus (right panel), measured as the percentage difference between the Cournot and the CCO allocation, under different corporate governance models from 1995 to 2021.

common ownership has more muted but still large distributional consequences. Similarly, using both uniform and firm-specific mitigation parameters we find that the estimated effect on aggregate profits and consumer surplus is about $+25\%$ and -12%, respectively. Thus, under various corporate governance assumptions common ownership leads to a sizeable deadweight loss that is increasing over time as well as to considerable distributional consequences that transfer rents from consumers to producers.

6 Extensions and Discussion

6.1 Private and Foreign Firms

Our empirical analysis so far has focused on public U.S. firms and has excluded foreign and privately held firms because the product similarity and ownership data for these firms is not as readily available. To circumvent these data problems our model can be extended to include a continuum of atomistic firms which do not share any ownership overlap with public firms. We assume that there is a continuum of atomistic firms that behave competitively and can enter and exit endogenously. The atomistic firms are ranked according to a productivity distribution. Following Hopenhayn (1992) we assume that atomistic firms are active if their productivity is sufficiently high.

For the sake of expositional simplicity, assume that the atomistic companies can be aggregated into a single representative firm. In our empirical implementation rather than just adding a single representative firm for all the private and foreign firms in the entire economy we add one representative firm for each of thirty macro-sectors. The representative firm varies in size over time and thereby captures both the intensive production margin (i.e., how much to produce) and the extensive margin (i.e., the entry and exit of atomistic firms). This representative firm is indexed by $i = n + 1$ which requires adding one row to the vectors $\mathbf{b}$ and $\mathbf{c}$ and a row and a column to the matrices $\mathbf{A}'\mathbf{A}$, $\mathbf{K}$, and $\mathbf{\Delta}$.

We assume that this representative firm behaves competitively and thus its first order condition is markedly different from that of the oligopolistic firms indexed by $\{1, 2, ..., n\}$. Recall that the first order condition for an oligopolistic firm is given by

$$\phi'(q_i) \;=\; 0. \tag{6.1}$$

In contrast, the representative firm prices at marginal cost and therefore maximizes total surplus $W(\mathbf{q})$. Thus, its first order condition is given by

$$W'(q_i) \;=\; 0 \qquad \text{for} \quad i = n + 1. \tag{6.2}$$

We can combine the first order conditions for oligopolistic firms and the representative firm in the following way:

$$\mathbf{0} \;=\; \left(\mathbf{b} - \mathbf{c}^0\right) - \left(\mathbf{I} + \mathbf{G} + \mathbf{\Delta} + \mathbf{\Sigma} + \mathbf{K} \circ \mathbf{\Sigma}\right)\mathbf{q} \tag{6.3}$$

where $\mathbf{G}$ is a diagonal matrix whose diagonal elements are equal to 1 for oligopolistic firms 1 to n and equal to 0 for the atomistic firm $n+1$. We assume that all private and foreign firms (and hence the representative firm) do not have any common ownership with any of the oligopolistic firms. As a result, $\mathbf{K}$ is as before but contains an additional row and column in which all off-diagonal elements are equal to zero:

$$\mathbf{G} \;=\; \begin{bmatrix} 1 & 0 & \cdots & 0 & 0 \\ 0 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 1 & 0 \\ 0 & 0 & \cdots & 0 & 0 \end{bmatrix} \qquad \text{and} \qquad \mathbf{K} = \begin{bmatrix} 1 & \kappa_{12} & \cdots & \kappa_{1n} & 0 \\ \kappa_{21} & 1 & \cdots & \kappa_{2n} & 0 \\ \vdots & \vdots & \ddots & \vdots & \\ \kappa_{n1} & \kappa_{n2} & \cdots & 1 & 0 \\ 0 & 0 & \cdots & 0 & 1 \end{bmatrix} \tag{6.4}$$

The equilibrium quantity vector under common ownership is now given by

$$\mathbf{q}^{\phi} \;=\; \left(\mathbf{I} + \mathbf{G} + \mathbf{\Delta} + \mathbf{\Sigma} + \mathbf{K} \circ \mathbf{\Sigma}\right)^{-1}\left(\mathbf{b} - \mathbf{c}^0\right). \tag{6.5}$$

For the empirical implementation of this extension we use the Compustat Historical Segments database to construct a measure of the domestic sales share for Compustat companies. First, we rescale all of Compustat firms' income statement data by the domestic sales share. Second, to identify the equilibrium size of the representative firms we estimate how much of the share of U.S. final demand is produced by private and foreign firms. We compute U.S. final demand (value added) for 30 broad sectors based on ISIC v3.1 classifications using the OECD Trade in Value Added (TiVA) dataset. Third, from this estimate we subtract the percentage share of final demand produced by U.S. public firms which we obtain by taking the ratio of the domestic sales revenues of Compustat firms and of final demand, defined as gross output plus imports minus exports.

We position the 30 representative firms in product characteristic space by augmenting HP's product similarity data with another database developed in Frésard, Hoberg and Phillips (2020). Their database constructs cosine similarities between products and Bureau of Economic Analysis (BEA) sectors by using descriptions of industries from the 2005 BEA Input-Output tables. We use the crosswalk between BEA and ISIC v3.1 developed in Pellegrino (2019) and match the cosine similarities to the ISIC v3.1 industries that correspond to our 30 representative firms.

Using these extended measures we can once again estimate the welfare impact of common ownership. Our estimates are shown in Figure 11. The addition of these representative firms changes our estimates of the deadweight loss of common ownership. This is due to our assumption that the ownership of public firms is distinct from that of private and foreign firms. The rise of common ownership primarily leads to less competitive behavior of U.S. public firms, but this is counterbalanced by the conduct of private and foreign firms.

6.2 Multi-product Firms

One important limitation of our analysis so far is that we assume that all firms produce one product each. We now relax this assumption. To do so, we augment the number of products in the economy to $\hat{n} \geq n$ and allow the n firms to produce more than one product. Importantly though, we assume that each product is still produced by only one firm. The product similarity matrix is now given by $\hat{\mathbf{\Sigma}}$ and has dimension $\hat{n} \times \hat{n}$.

We denote the augmented ownership matrix by $\hat{\mathbf{K}}$. This matrix is symmetric and has dimension $\hat{n} \times \hat{n}$. $\hat{\mathbf{K}}$ has a simple structure. Its (i, j) entry $\hat{\kappa}_{ij}$ is equal to one if product i and j are produced by the same firm. Otherwise, $\hat{\kappa}_{ij}$ is equal to the κ_{ij} computed based on the shareholder ownership stakes of the two firms that produce products i and j. The equilibrium quantity vector under common ownership is now given by

$$\mathbf{q}^{\phi} \;=\; \left(2\mathbf{I} + \mathbf{\Delta} + \hat{\mathbf{\Sigma}} + \hat{\mathbf{K}} \circ \hat{\mathbf{\Sigma}}\right)^{-1} \left(\mathbf{b} - \mathbf{c}^{0}\right). \tag{6.6}$$

In our empirical implementation, we employ Compustat segments data to separate by business segments the sales of a substantial subset of firms in the Compustat data. Each segment is linked to a specific SIC code. We characterize a product as a subset of segments affiliated with the same 4-digit SIC code, treating firms that report sales across multiple segments with distinct SIC codes as multi-product entities. To delineate their operations across products, we use their Compustat segments sales share and the connections between products and firms to derive the augmented ownership matrix $\hat{\mathbf{K}}$.

Next we construct the augmented product similarity matrix $\hat{\mathbf{\Sigma}}$. Here we follow previous work by Hoberg and Phillips (2018) who combine firm-level cosine similarities and segment SIC codes. This allows them to build a cosine similarity matrix for products/segments, denoted by $(\mathbf{A}'\mathbf{A})_P$, rather than for firms, denoted by $(\mathbf{A}'\mathbf{A})_F$ and used thus far in our analysis. The exact step-by-step procedure is described in Pellegrino (2019). Loosely speaking, to compute the similarity of a product i with respect to any other product, this involves combining the 10-K description of the firm selling product i with the 10-K descriptions of all other firms that also sell products in i's SIC code and weighting each description by the associated firm's sales share in that particular SIC code.

Using this extended multi-product model the estimated deadweight loss of common ownership is even larger than in our baseline case as shown in Figure 11. This is because in the multi-product setting the product set is even larger with more variety and thus more opportunity for within- and across-firm internalization of production decisions.

6.3 Complements

The GHL demand system assumes that all goods in the economy are imperfect substitutes or independent products and that there are no complements. This restriction is due to that fact that the $\mathbf{A}'\mathbf{A}$ matrix is non-negative by construction and hence $\mathbf{\Sigma}$ is also non-negative. Complements would be represented by negative entries in the Σ matrix.

In the presence of complementarities between products i and j, oligopolistic behavior still leads to an undersupply of goods i and j because the firms do not internalize the positive spillovers that their own products have on complementary goods. However, common ownership between firms i and j partially resolves this inefficiency and thus has a pro-competitive rather than an anti-competitive effect. Because the framework of Hoberg and Phillips (2016) on which our empirical implementation rests, limits us to a non-negative $\mathbf{A}'\mathbf{A}$ matrix, our estimates of the welfare cost of common ownership are upwardly biased if products are in fact complements.

Although we cannot measure complements directly we can nonetheless investigate how sensitive our results are to the presence of complements. For every year of observation, we randomly select five percent of product pairs i and j and flip the sign of their corresponding elements in the product similarity matrix Σ such that $\sigma_{ij} = \sigma_{ji} < 0$, thereby creating artificial complements. We then re-estimate our models with this altered product similarity matrix. Figure 11 shows that the deadweight loss of common ownership is slightly smaller than our baseline estimates suggest and the gap marginally grows over time with the increase in common ownership. Complementarities alleviate the deadweight loss of common ownership because common ownership leads firms with complementary products and common owners to produce more than they would under standard Cournot competition.

6.4 Geography and Tradable Industries

One of the limitations of our approach is that it does not differentiate between geographical markets within the United States. This is because we use the data of Hoberg and Phillips (2016) who omit geographical words including country and state names, as well as the names of the top fifty cities

Figure 11: Common Ownership DWL - Extensions

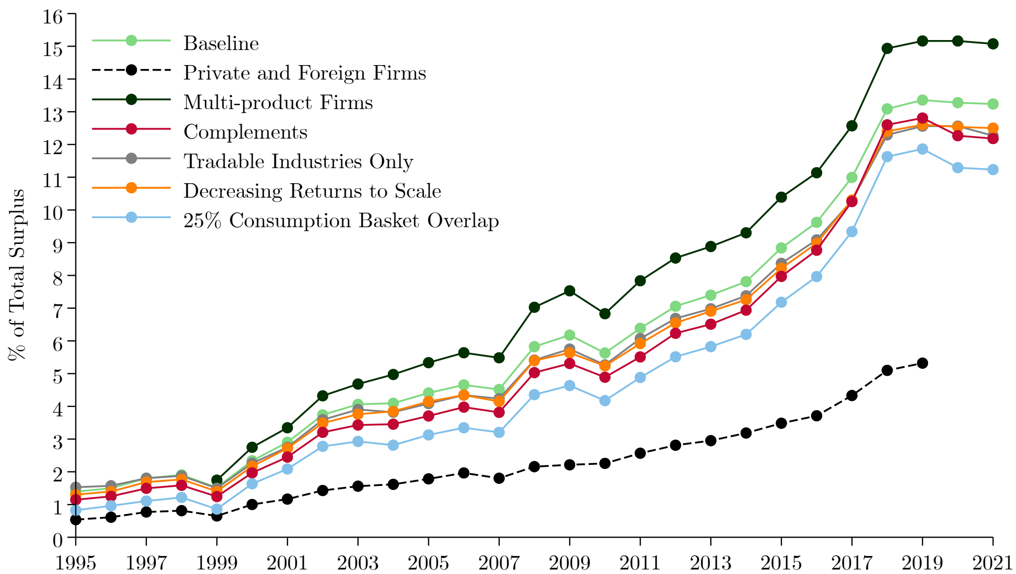

Figure Notes: The figure plots the deadweight loss of common ownership, computed as % of the total surplus with private and foreign firms, multi-product firms, complements, only tradable industries, decreasing returns to scale, and a 25% overlap in the consumption baskets of corporate managers and the representative agent. All estimates assume that firms use Rotemberg proportional common ownership weights.

in the US and in the world. However, as they discuss in their paper, their results are robust to altering these word exclusions.

Although we cannot obtain information on the geographic breakdown of sales within the United States, we can nonetheless provide evidence that our results are not the artifact of ignoring geography. Specifically, we can estimate our model using only firms in tradable sectors and thus excluding firms in non-tradable sectors for which exact geographic locations (both their own and those of their competitors) are much more important. In Figure 11 we show that our results are largely unchanged compared to our baseline.

6.5 Empirical Results

We now compare the results of these various extensions (using proportional Rotemberg common ownership weights throughout) to our benchmark case which assumes no private or foreign firms, only single-product firms, only substitutes, constant returns to scale, and no overlap in the consumption baskets of corporate managers and the representative agent.

In Figure 11 we plot the evolution of the deadweight loss that is due to the presence of common ownership under different extensions of our model presented in Section 6.1 to 6.4. We also consider two further extensions allowing for decreasing returns to scale and accounting for some overlap in the consumption baskets of corporate managers and the representative consumer which we discuss in Section B.1 and B.2. For all specifications we assume that firms use Rotemberg proportional common ownership weights as in our baseline model. First, our results providing evidence for the large and growing welfare impact of common ownership continue to hold across all of our extensions. The estimated deadweight losses in 1995 range between 0.5% and 1.5% of total surplus, but rise to between 5.3% and 15.1% by 2021 (or 2019, the last year for which data for representative private and foreign firms are available). Second, most of our extensions, in particular multi-product firms, decreasing returns to scale, complements, tradable industries, and a 25% consumption basket overlap, lead to very similar results as our baseline model. For four of these extensions the deadweight loss is slightly lower than in our baseline model whereas with multi-product firms it is slightly larger. Third, the only extension that leads to markedly different results (though they still follow the same time trend) is when we account for the presence of private and foreign firms. In this extension, the deadweight loss is only about a third as large as under our baseline.

This markedly lower deadweight loss when we account for private and foreign firms is due to three facts. First, the relative share of the surplus generated by private and foreign firms increases over time in our sample due to a reduction in the number of public firms. Second, and more importantly, private and foreign firms are assumed to be independently owned and thus the secular increase in common ownership does not tamper their competitive behavior. Third, the rise of common ownership leads to a supply reduction of the commonly-owned firms which, given the strategic substitutability under Cournot competition, in turn induces private and foreign firms to expand output thus mitigating the deadweight loss of common ownership.

Thus, under various extensions, our conclusion that common ownership leads to a increasingly sizeable deadweight loss as well as to considerable distributional consequences that transfer rents from consumers to producers continues to hold. Even our most conservative estimates which result from using the Azar and Ribeiro (2022) mitigation parameter model and accounting for the presence of private and foreign firms, suggest a deadweight loss of approximately 1.5% of total surplus.

6.6 Bertrand Oligopoly

Our analysis deliberately focuses on Cournot competition because we obtain a model that is both tractable and flexible. All of our analyses can be replicated under the assumption of Bertrand competition. However, the Bertrand case is significantly less tractable, more computationally involved, and the resulting equilibrium equations are harder to interpret. In Appendix B.3 we derive the Bertrand equilibrium with common ownership for the case with a flat marginal cost function (i.e., $\boldsymbol{\Delta} = \mathbf{0}$).

Nonetheless, it is interesting to consider how our results would change if we assumed that firms competed on price as opposed to quantity. Because Bertrand competition in our model is more intense than Cournot competition and hence results in higher equilibrium quantities, the deadweight loss from oligopoly is smaller when firms set prices rather than quantities. However, because the monopoly solution is independent of whether prices or quantities are chosen and common ownership moves the economy closer to the monopoly potential, the incremental anticompetitive effect of common ownership relative to the standard oligopoly solution is more pronounced under Bertrand than under Cournot competition. Hence, our estimates of the deadweight loss of common ownership obtained under Cournot competition are more conservative.

6.7 Limitations

In our analysis 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). However, there are several other firm decisions which are affected by common ownership. For example, recent theoretical and empirical contributions suggest that common ownership may also affect labor market power (Azar and Vives, 2021a), incentives to collude (Pawliczek, Skinner and Zechman, 2019; Shekita, 2022), firm productivity and cost efficiency (Antón et al., 2023b), innovation (?López and Vives, 2019; Eldar et al., 2020; Li et al., 2020), entry (Newham et al., 2019; Xie and Gerakos, 2020), and the ownership structure of companies (Piccolo and Schneemeier, 2020; Antón, Ederer, Giné and Pellegrino, 2023a). In addition, common ownership may affect firms' product differentiation choices.

Although the quantification of these additional channels through which common ownership ultimately affects outcomes across the entire economy suggests several fruitful research opportunities, a formal investigation of these channels using our current theoretical framework and empirical methodology is beyond the remit of this paper. Nonetheless, we can conjecture how these additional considerations might affect our conclusions about the welfare impact of common ownership.

First, the labor market power resulting from common ownership (Azar and Vives, 2021a) would lead to wage markdown, lower employment, and lower output thus further increasing the deadweight loss of common ownership that we estimate in the paper. Second, common ownership can facilitate both tacit and explicit collusion (Pawliczek et al., 2019; Shekita, 2022) which would further restrict quantities and increase deadweight loss. Third, common ownership can lead to lower managerial incentives and reduced firm productivity (Antón et al., 2023b) generating additional welfare losses. Fourth, common ownership can have a pro-competitive and welfare-increasing effect if it leads firms to internalize the positive spillovers of privately costly innovation (?López and Vives, 2019) which in turn would improve firm productivity and increase output. This would imply that our results overestimate the welfare losses of common ownership. Fifth, the welfare effects of common ownership due to changes in entry decisions (Newham et al., 2019; Xie and Gerakos, 2020) and ownership arrangements (Piccolo and Schneemeier, 2020) are generally ambiguous and thus it is difficult to hypothesize how considering these choices would affect our conclusions. Finally, by taking product positioning as exogenous we do not capture the (pro-competitive) effect of common ownership that reduces firms' product differentiation incentives and leads firms to be in closer competition to each other than they would be in the absence of common ownership.

7 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, based on the assumption that firms maximize a share-weighted sum of the income of their shareholders, indicate that the rise of common ownership led to considerable deadweight losses. In addition, the increase in common ownership leads to a significantly lower share of total surplus accruing to consumers. The key insights of our findings also continue to hold under alternative corporate governance assumptions such as superproportional influence, blockownership thresholds, limited investor attention, and managerial entrenchment as well as for a range of extensions.

The economically large impact of common ownership predicted by our model suggests that its continuing increase carries important implications for antitrust policy and financial regulation, and thus justifies the increasing scrutiny of this phenomenon by regulatory agencies.

Our analysis focuses only on one specific mechanism (i.e., unilateral effects in Cournot product market competition) through which common ownership among firms affects the size and the distribution of surplus in the U.S. economy. It does not consider the impact of common ownership through other channels such as labor market power, innovation, entry, productivity, and product positioning. We leave the quantification of these additional channels as well as the evaluation of policy proposals aimed at curtailing the anticompetitive effects of common ownership to future research.

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A Appendix

This appendix contains additional tables which are referred to in the main text.

Table A.1: Welfare Estimates (1995)

	Scenario	*Common Ownership*	*Cournot-Nash*	*Perfect Competition*	*Monopoly*
		(1)	(2)	(3)	(4)
Welfare Statistic	**Variable**	$\mathbf{q}^{\Xi}$	$\mathbf{q}^{\phi}$	$\mathbf{q}^{W}$	$\mathbf{q}^{\Pi}$
Total Surplus (US$ trillions)	$W(\mathbf{q})$	5.632	5.712	6.206	4.437
Aggregate Profits (US$ trillions)	$\Pi(\mathbf{q})$	1.003	0.900	0.000	2.668
Consumer Surplus (US$ trillions)	$\mathrm{CS}(\mathbf{q})$	4.629	4.811	6.206	1.769
Total Surplus / Perfect Competition	$\frac{W(\mathbf{q})}{W(\mathbf{q}^W)}$	0.907	0.920	1.000	0.715
Aggregate Profit / Total Surplus	$\frac{\Pi(\mathbf{q})}{W(\mathbf{q})}$	0.178	0.158	0.000	0.601
Consumer Surplus / Total Surplus	$\frac{\mathrm{CS}(\mathbf{q})}{W(\mathbf{q})}$	0.822	0.842	1.000	0.399

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 A.2: Difference between CCO and Cournot Profits for Selected Companies

Top 10 Companies ranked by $ profit difference net of fixed costs (in millions), 2021

Company Name	**CCO Profits**	**Cournot Profits**	**Difference**	**% Diff.**
Microsoft	$ 80,816.0	$ 67,888.6	+$ 12,927.4	+19.04%
Walmart	$ 36,037.0	$ 23,270.3	+$ 12,766.7	+54.86%
Alphabet	$ 91,144.0	$ 82,064.3	+$ 9,079.7	+11.06%
AT&T	$ 51,469.0	$ 44,108.4	+$ 7,360.6	+16.69%
Dell	$ 10,791.0	$ 3,578.8	+$ 7,212.2	+201.53%
Verizon	$ 47,948.0	$ 40,737.0	+$ 7,211.0	+17.70%
Oracle	$ 18,564.0	$ 12,033.0	+$ 6,531.0	+54.28%
Amazon	$ 47,850.0	$ 41,702.4	+$ 6,147.6	+14.74%
Home Depot	$ 23,051.0	$ 16,930.2	+$ 6,120.8	+36.15%
CVS	$ 17,944.0	$ 11,850.5	+$ 6,093.5	+51.42%

Bottom 10 Companies ranked by $ profit difference net of fixed costs (in millions), 2021

Company Name	**CCO Profits**	**Cournot Profits**	**Difference**	**% Diff.**
Solaredge	$ 248.0	$ 638.4	-$ 390.3	-61.15%
Ciena	$ 611.3	$ 1,059.3	-$ 448.0	-42.29%
Five9	$ 1.7	$ 497.4	-$ 495.7	-99.66%
Liberty Broadband	$ 264.0	$ 915.2	-$ 651.2	-71.16%
Mastec	$ 842.7	$ 1,541.9	-$ 699.2	-45.35%
Palo Alto Networks	$ 1.8	$ 718.6	-$ 716.8	-99.75%
PSEG	$ 360.0	$ 1,095.5	-$ 735.5	-67.14%
Etsy	$ 576.7	$ 1,320.1	-$ 743.4	-56.32%
Generac Holdings	$ 828.6	$ 1,675.0	-$ 846.3	-50.53%
Ulta Beauty	$ 569.0	$ 1,457.7	-$ 888.7	-60.97%

B Online Appendix

This online appendix contains the descriptions for additional model extensions.

B.1 Decreasing Returns to Scale

Recall that in our baseline model each firm's cost function is quadratic

$$h_i = f_i + c_i^0 q_i + \frac{1}{2}\delta_i q_i^2. \tag{B.1}$$

Our analysis so far assumed that firms have constant marginal costs, $\delta_i = 0$, which is a common assumption in the industrial organization literature. We now relax this assumption.

We follow the approach of Pellegrino (2019) of bounding the δ_i parameter using a set identification result that is specific to this quadratic cost function. This result requires the assumption that the marginal cost function respects non-negativity ($c_i \geq 0$) and non-increasing returns to scale ($\partial c_i / \partial q_i \geq 0$) and only applies to firms for which observed revenues are at least twice total variables costs. We further assume, like DEU, that the parameter controlling the scale elasticity δ_i is the same for all firms that belong to the same sector (2-digit NAICS). With these assumptions in hand we have

$$\delta_{\mathcal{S}(i)} \leq \min_{i' \in \mathcal{S}(i) \cap \mathcal{F}} \frac{2 \times \mathrm{TVC}_i}{p_i q_i - 2 \times \mathrm{TVC}_i} \tag{B.2}$$

where $\mathcal{S}(i)$ is the set of firms in the sector to which firm i belongs and $\mathcal{F}$ is the set of firms whose revenues are at least twice total variable costs. We use this upper bound for δ_i because assigning any lower value to this parameter would just yield estimates that are closer to those of our baseline model where $\delta_i = 0$. Figures B.1 to B.6 show the distribution and evolution over time of the implied markups and compare them to those estimated by Pellegrino (2019) and De Loecker et al. (2020).

B.2 Consumption Baskets of Corporate Managers

A limiting assumption of our baseline model is that corporate managers are assumed to spend all of their income on a luxury good. Thus, each manager's consumption basket is assumed to be entirely distinct from that of the representative consumer-worker-owner. It is therefore natural to ask how our conclusions would change if corporate managers instead consumed some of the goods consumed by the representative agent.

The manager of firm i chooses his consumption bundle of oligopolistically-produced goods $\mathbf{q}^i$ to maximize utility

$$\max_{\mathbf{q}^i} U^i = \mathbf{b}'\mathbf{q}^i - \frac{1}{2\rho\varepsilon}\mathbf{q}^{i\prime}\left(\mathbf{I} + \Sigma\right)\mathbf{q}^i + \ell \tag{B.3}$$

$$\text{st. } \mathbf{p}'\mathbf{q}^i + \ell \leq \varepsilon\phi_i \tag{B.4}$$

where ℓ is the luxury good produced only through labor with a linear production technology and $\rho \in [0, 1]$ is a parameter that controls the correlation of the manager's taste with that of the representative consumer. Furthermore, ϕ_i is the normalized shareholder income for firm i and ε is the (arbitrarily small) manager's share of these portfolio profits.

From the utility function the manager's inverse demand is

$$\mathbf{p} = \mathbf{b} - \frac{1}{\rho\varepsilon}\left(\mathbf{I} + \Sigma\right)\mathbf{q}^i \tag{B.5}$$

which implies that

$$\mathbf{q}^i = \rho\varepsilon\mathbf{q}. \tag{B.6}$$

Because demand is quasi-linear we have

$$\ell = \varepsilon\phi_i - \mathbf{p}'\mathbf{q}^i. \tag{B.7}$$

Substituting the expressions for ℓ and $\mathbf{q}^i$ in the manager's utility function we obtain

$$U^i = \rho\varepsilon\left[\mathbf{q}'\left(\mathbf{b}-\mathbf{p}\right) - \frac{1}{2}\mathbf{q}'\left(\mathbf{I}+\Sigma\right)\mathbf{q}\right] + \varepsilon\phi_i \tag{B.8}$$

which we can rewrite as

$$U^i \propto \rho\text{CS} + \phi_i \tag{B.9}$$

where we used the definition for consumer surplus from equation (2.5).

The parameter ρ captures the extent to which the consumption basket of the manager loads on non-luxury goods. The more the manager consumes non-luxury goods, the more they will internalize consumer surplus. If $\rho = \kappa_{ij} = 1$ for all i, j pairs then each corporate manager maximizes total surplus. In contrast, if $\rho = 0$, we are back to our baseline case and the manager only maximizes weighted shareholder portfolio profits ϕ_i.

B.3 Bertrand Oligopoly with Common Ownership

We derive the Common Ownership Bertrand-Nash equilibrium under the simplifying assumption $\mathbf{\Delta} = \mathbf{0}$ (that is, under the assumption that all firms have a flat marginal cost function). We start by writing the vector of profit functions as a function of prices:

$$\pi \;=\; \text{diag}\left(\mathbf{p}-\mathbf{c}\right)\left[\mathbb{D}\left(\mathbf{b}-\mathbf{p}\right)+\mathbb{O}\left(\mathbf{b}-\bar{\mathbf{p}}\right)\right] \tag{B.10}$$

where $\mathbb{D}$ and $\mathbb{O}$ are, respectively, the matrices containing the diagonal and the off-diagonal elements of the matrix $\left(\mathbf{I}+\mathbf{\Sigma}\right)^{-1}$. We use the bar symbol ($\overline{\mathbf{p}}$) to indicate that firm i takes the prices of all other firms j as given. Then the system of first order condition is:

$$\mathbf{0} \;=\; \left[\mathbb{D}\left(\mathbf{b}-\mathbf{p}\right)+\mathbb{O}\left(\mathbf{b}-\bar{\mathbf{p}}\right)\right] - \mathbb{D}\mathbf{p} + \mathbb{D}\mathbf{c} \tag{B.11}$$

The Bertrand equilibrium is the fixed point $\mathbf{p} = \overline{\mathbf{p}}$. By imposing this equality and re-writing this equation system in terms of the quantity vector ($\mathbf{q}$) we obtain:

$$\mathbb{D}\left(\mathbf{b}-\mathbf{c}\right) \;=\; \mathbf{q} + \mathbb{D}\left(\mathbf{I}+\mathbf{\Sigma}\right)\mathbf{q} + \left(\mathbf{K}\circ\mathbb{O}\right)\left[\mathbf{b}-\mathbf{c}-\left(\mathbf{I}+\mathbf{\Sigma}\right)\mathbf{q}\right] \tag{B.12}$$

We finally solve for the Bertrand equilibrium quantity vector $\mathbf{q}^{\text{B}}$:

$$\mathbf{q}^{\text{B}} \;=\; \left[\mathbf{I}+\mathbb{D}^{-1}+\mathbf{\Sigma}+\mathbb{D}^{-1}\left(\mathbf{K}\circ\mathbb{O}\right)\left(\mathbf{I}+\mathbf{\Sigma}\right)\right]^{-1}\left[\mathbf{I}+\mathbb{D}^{-1}\left(\mathbf{K}\circ\mathbb{O}\right)\right]\left(\mathbf{b}-\mathbf{c}\right) \tag{B.13}$$

B.4 Product Market Centrality

We provide additional information about the evolution of centrality over time. Following Pellegrino (2019) given an equilibrium quantity vector which could be the result of Cournot competition with or without common ownership, the product market centrality χ_i of firm i is defined as

$$\chi_i: \qquad q_i \;=\; \frac{1-\chi_i}{2}\cdot\left(b_i - c_i\right) \tag{B.14}$$

where $c_i = c_i^0 + \delta_i q_i$ is the marginal cost. For this application we assume, as in our baseline model, a flat marginal cost function (i.e., $c_i = c_i^0$).

$(1 - \chi_i)$ is a generalized eigenvector because it is derived by replacing the inverted matrix (which depends on $\mathbf{\Sigma}$) in the equilibrium quantity equation with a diagonal matrix. It summarizes the entire matrix $(2\mathbf{I} + \mathbf{\Sigma} + \mathbf{K} \circ \mathbf{\Sigma})^{-1}$ in a single vector. For example, for the Cournot with common ownership case we have

$$\mathbf{q} \quad = \quad (2\mathbf{I} + \mathbf{\Sigma} + \mathbf{K} \circ \mathbf{\Sigma})^{-1} (\mathbf{b} - \mathbf{c}) \quad = \quad \frac{1}{2} (1 - \boldsymbol{\chi}) \circ (\mathbf{b} - \mathbf{c}) \tag{B.15}$$

This measure of centrality ranges from zero to one and links the network topology to a firm's ability to influence price. When $\chi_i \to 0$, firm i is completely peripheral and entirely insulated from product market pressures. It therefore charges the monopoly markup. When $\chi_i \to 1$, firm i faces many competitors supplying products with very similar characteristics and thus behaves as under perfect competition. Figure B.7 plots the distributions of the product market centrality for Cournot competition with and without common ownership in 1995 and 2021.

Figure B.1: Implied Markup Distribution

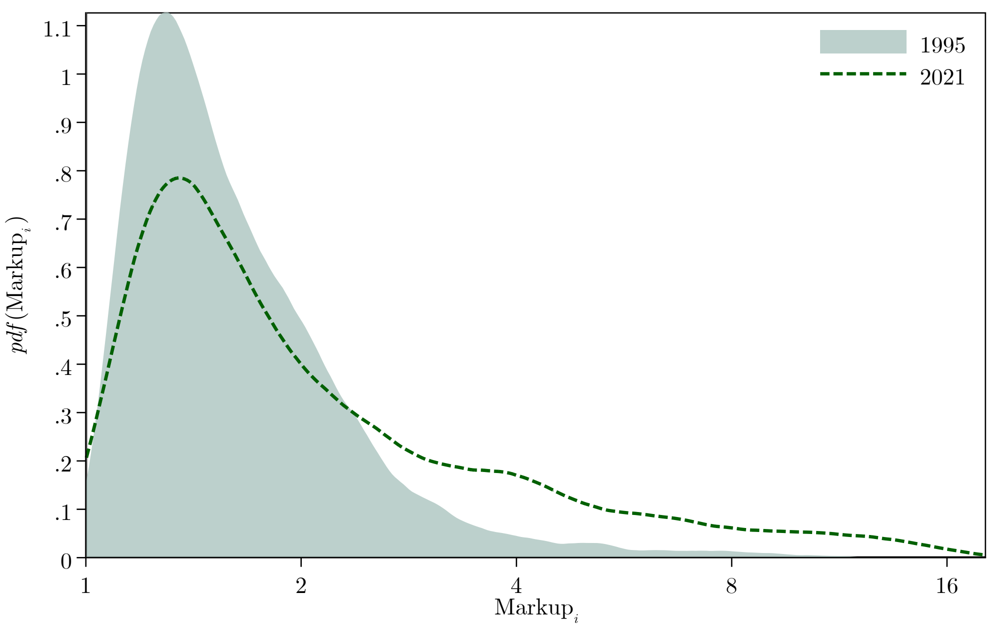

Figure Notes: The figure plots the distribution of firm markups estimated by our model with decreasing returns to scale under common ownership in 1995 and 2021.

Figure B.2: Evolution of Markup Percentiles

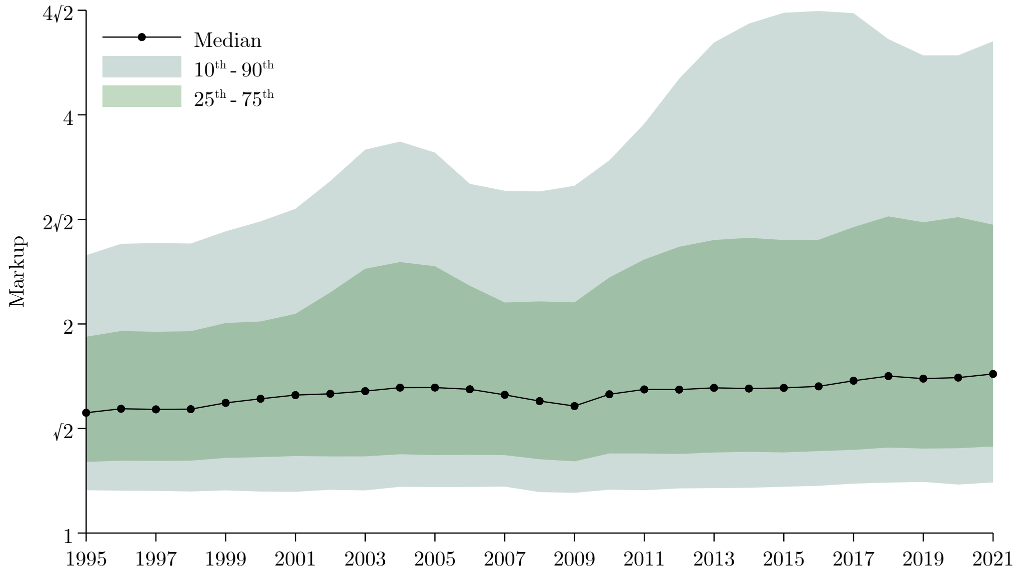

Figure Notes: The figure plots the 10th, 25th, 50th, 75th, and 90th percentiles of firm markups estimated by our model with decreasing returns to scale under common ownership from 1995 to 2021.

Figure B.3: Comparison of Markups with Pellegrino (2019)

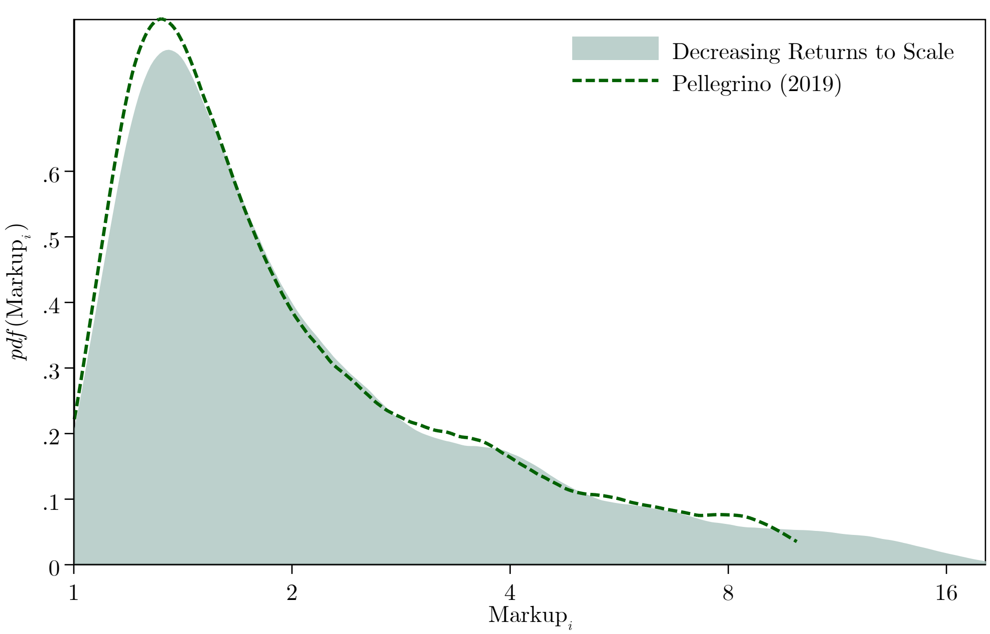

Figure Notes: The figure plots the distribution of firm markups estimated by our model with decreasing returns to scale under common ownership and by Pellegrino (2019) in 2021, the most recent year of our and his sample.

Figure B.4: Comparison of Markups with De Loecker et al. (2020)

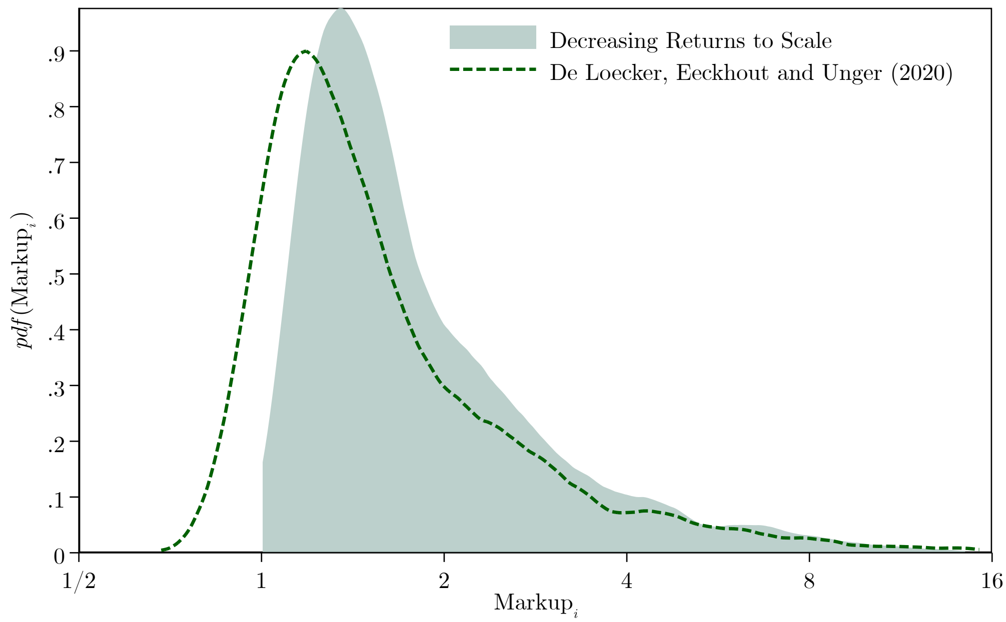

Figure Notes: The figure plots the distribution of firm markups estimated by our model with decreasing returns to scale under common ownership and by De Loecker et al. (2020) in 2016, the most recent year of their sample.

Figure B.5: Comparison of Markup Evolution with De Loecker et al. (2020)

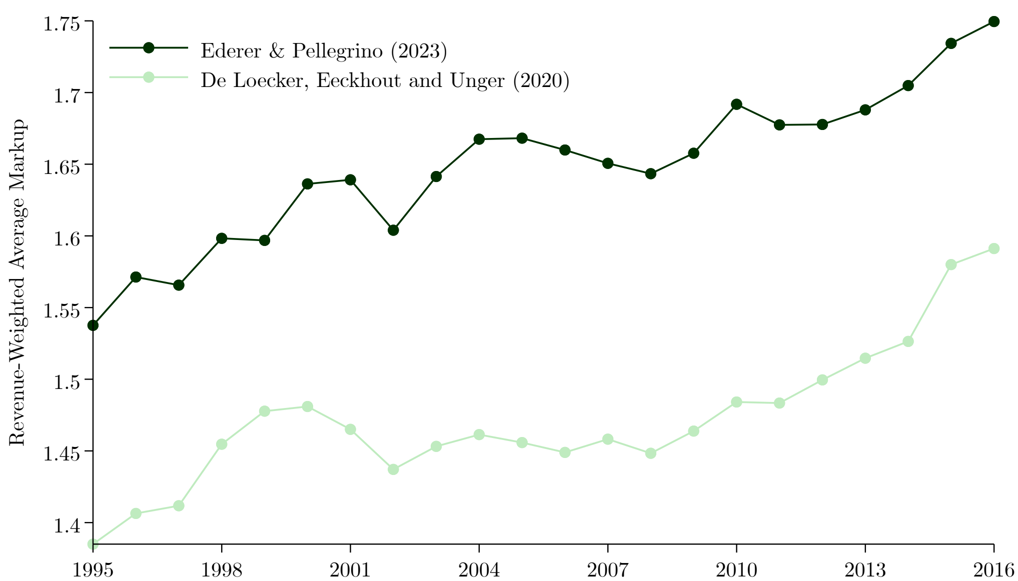

Figure Notes: The figure plots the revenue-weighted average markup estimated by our model with decreasing returns to scale under common ownership and by De Loecker et al. (2020) using the most recent available year for each firm.

FIGURE B.6: CROSS-SECTIONAL COMPARISON OF MARKUPS WITH DE LOECKER ET AL. (2020)

FIGURE NOTES: The figure plots the markups estimated by our model with decreasing returns to scale under common ownership against those estimated by De Loecker et al. (2020) in 2016, the most recent year of their sample. We only use firms that are present in both datasets.

FIGURE B.7: PRODUCT MARKET CENTRALITY

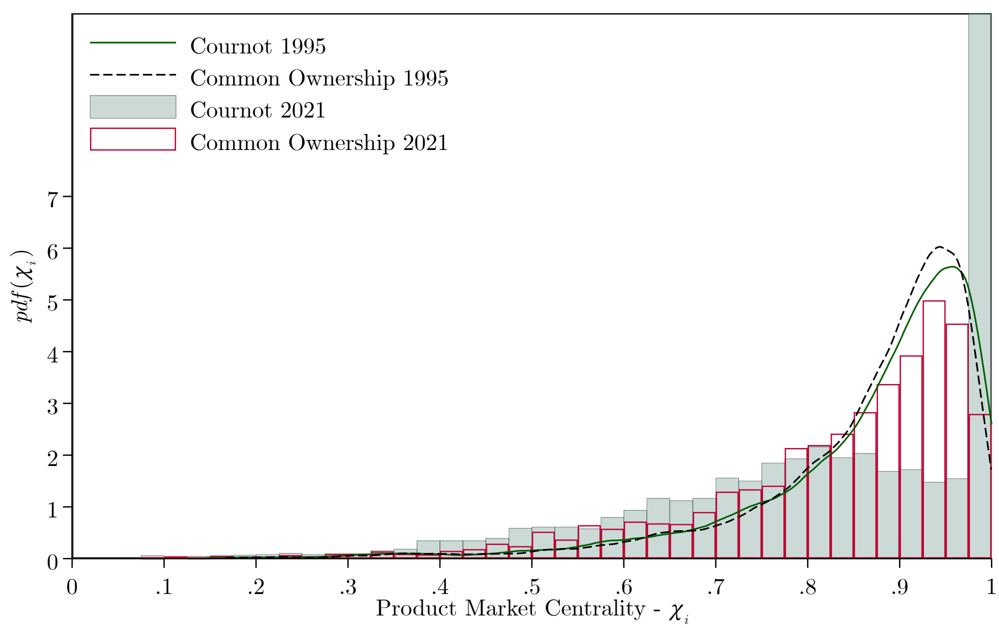

FIGURE NOTES: The figure plots the distribution of product market centralities under Cournot competition and Cournot competition with common ownership in 1995 and 2021.