Common Ownership, Corporate Control and Price Competition*

Anna Bayona † Ángel L. López ‡ Anton-Giulio Manganelli§

February 2022

Abstract

We examine price competition with homogeneous products in the presence of general common ownership arrangements allowing for different corporate control structures. We show that equilibria with positive profits exist (including the monopoly outcome) when the manager places the same weight on the profit of her firm as on the average profit of all the other firms. This condition supports symmetric and asymmetric stakes and can arise as an equilibrium of a network formation game or a bargaining process.

Keywords: partial ownership, proportional control, silent financial interests, Bertrand competition, minority shareholders.

JEL codes: L11, L40, G34.

*We thank two anonymous referees, Joseph Harrington, Sjaak Hurkens, Konstantinos Papadopoulos, Martin Schmalz, Geert Van Moer, and the participants to the CRESSE 2021, SAEe 2021 conferences, and the 2022 workshop "Diversified institutional ownership and firms' strategic behavior: causal effects and mechanisms" for their insightful comments. Bayona acknowledges the financial support from Banc Sabadell, the Generalitat de Catalunya (AGAUR grant 2017 SGR 640), and the Spanish Ministry of Science, Innovation and Universities (Grant: PGC2018-098670). López acknowledges the financial support from the Spanish Ministry of Science, Innovation and Universities and the European Regional Development Fund through grant PGC2018-096325-B-I00, and from AGAUR under 2017 SGR 1301.

†Anna Bayona, ESADE Business School, Universitat Ramon Llull, Av. Pedralbes, 60-62, 08034 Barcelona (Spain). Tel. +34 932 806 162. E-mail address: anna.bayona@esade.edu

‡Ángel L. López, Institute for Economic Analysis (CSIC), 08193 Bellaterra, Barcelona (Spain), and Barcelona School of Economics (Spain). E-mail address: angel.lopez@iae.csic.es

§Anton-Giulio Manganelli, EADA Business School, C. d'Aragó, 204, 08011 Barcelona (Spain). E-mail address: amanganelli@eada.edu

1 Introduction

The phenomenon of common investors in firms from the same industry is widespread, and was originally documented by Azar (2011, 2012). These external common investors include investment managers, conglomerate holding companies, pension and hedge funds, among others, and are present in such different sectors as technology, pharmaceuticals, banks, and airline industries. Common ownership has become even more important in the last decades: the proportion of institutional investors that simultaneously hold at least 5% of the shares of US public firms in the same industry has increased from less than 10% in 1980 to 60% in 2014 (He and Huang 2017). Furthermore, Backus et al. (2021a) document the increase of common ownership from 1980 among S&P 500 firms, and show it is driven by both an increase in size of large asset management companies and by the increased diversification of institutional investors. These events have attracted attention from competition authorities which are concerned with their potential anticompetitive effects.[1]

The theoretical literature has shown that horizontal overlapping ownership structures generally reduce competition, however, there is limited theoretical research on the relationship between common ownership arrangements, control structures, and prices. In this paper, we aim at filling this gap by addressing the following research questions: What is the privately optimal common ownership structure? Can this structure arise as an equilibrium? How does this equilibrium depend on the corporate control structure?

We answer these questions in a model with a finite number of symmetric firms that compete à la Bertrand with homogeneous goods.[2] We focus on a general framework that allows for different degrees of control, and which encompasses typical examples of common ownership such as: (i) proportional control, where managers take investors' control interests in proportion to their financial interests. This structure resembles the case of mutual and hedge funds as common investors in many industries (see, for example,

[1] See Posner et al. (2017), Bebchuk et al. (2017), Schmalz (2018), and Azar and Schmalz (2017).

[2] Examples of recent papers in other related contexts that use the model of Bertrand competition with homogeneous products are Bernheim and Masden (2017) and Sugaya and Wolintzky (2018).

Schmalz 2018), and more generally, it approximates the case of institutional investors;[3] (ii) non-proportional control structures, such as multiple classes of shares with different voting rights, and silent financial interests where each firm has a controlling investor and might also be partially owned by other shareholders with financial stakes and no control rights. This may be due to various scenarios, such as non-voting stock or non-proportional stock, constraints on the control of the acquired firm, or the acquisition of a financial interest which is too small to have effective decision rights.[4]

To model common ownership, we follow Salop and O'Brien (2000): the manager of a firm maximizes a weighted average of the investors' portfolio profits given the existing common ownership. In this context, we examine the ownership and control structures that constitute an equilibrium with common prices and positive profits. Finally, we discuss the investors' strategic incentives to form these structures in a network formation game with transfers and in a Nash bargaining process among investors.

Our main result is as follows. With common ownership, we find that any price between the marginal cost and the monopoly price can be an equilibrium provided that the weight a manager places on her firm is equal to the average weight in all other firms. The rationale for this equilibrium condition is that the profits from deviating from the common price are equal to the profits from maintaining the common price. Our analysis shows that, with common ownership, firms can sustain the monopoly price even in Bertrand competition with homogeneous products. Moreover, common price equilibria with positive profits can be supported by both symmetric and asymmetric common ownership configurations.

We also show that the higher the number of other firms, the higher the total stakes that investors must own of these in order to deter firms' managers from deviating in the price competition stage. The intuition is that, when the number of firms increases, the incentives to deviate also increase because a common price implies that industry profits must be shared among a higher number of firms. In order to make firms' managers unwilling to deviate, they must give more weight to other firms' profits: if investors own

[3] Note that passive investors do not necessarily imply passive ownership (Appel et al. 2016).

[4] We refer to Salop and O'Brien (2000) for further possibilities regarding other partial ownership structures.

a higher fraction of other firms' shares, then each manager will internalize less of her own firm's profit and more of other firms' profits.

We also analyze ownership configurations that support such price equilibria of an extended game in which investors, before price competition, can strategically acquire rival firms' shares and/or sell own shares under a given corporate control. We explore two possibilities focusing on the payoff dominant equilibrium refinement for the pricing stage. The first is a network formation game with transfers among investors. We find that, for any given corporate control structure, any ownership configuration that satisfies the equilibrium condition with positive profits is pairwise stable. The second considers the acquisition of stakes by investors as a bargaining game. We find that the ownership configurations that support positive profits requires that the distribution of bargaining power among investors equals the ratio of the average stake in all firms owned by a given investor to the average fraction of non-minority shares in each firm.

Previous theoretical work has shown that horizontal overlapping ownership arrangements generally reduce competition in imperfectly competitive markets (Rotemberg 1984; Bresnahan and Salop 1986; Reynolds and Snapp 1986; Farrell and Shapiro 1990; Salop and O'Brien 2000; Azar, 2011; Azar, 2012; Shelegia and Spiegel 2012).[5] In relation to this literature, we focus on Bertrand competition with homogeneous products and symmetric costs allowing for investors to have different degrees of control over firms. We find the conditions in which firms can replicate the monopoly outcome and discuss how the privately optimal structures can be supported as equilibria of ownership formation games.

Our paper is closely related to Azar (2011, 2012) and Shelegia and Spiegel (2012), which show that firms can replicate the monopoly outcome through common ownership. Azar (2011, 2012) examined the effects of common ownership with homogeneous goods Bertrand competition with proportional control and completely diversified investors, while Shelegia and Spiegel (2012) consider asymmetric homogeneous Bertrand compe-

[5] This framework has been extended to consider collusion (Gilo et al. 2006); mergers (Foros et al. 2011); R&D investments (López and Vives 2019; Bayona and López 2018; Papadopoulos et al. 2019); and managerial incentives (Anton et al. 2020).

tition with silent financial interests. In relation to these, our model encompasses general ownership arrangements allowing for different degrees of corporate control structures beyond silent financial interests and proportional control. In addition, our paper analyzes investors' strategic incentives to form these ownership and control arrangements using a network formation game or a bargaining process.

The effects of common ownership have also been documented in empirical work, where results are more mixed – in some cases showing an increase in prices, in other cases showing a non-statistically significant effect (O'Brien and Waehrer 2017; Azar et al. 2018; Nain and Wang 2018; Park and Seo 2019; Lewellen and Lowry 2021; Backus et al. 2021b; Koch et al. 2021). See Schmalz (2018) for a recent survey of this literature.

Our analysis is as follows: Section 2 describes the model which focuses on the ownership, control and competition structures; Section 3 derives the results for price competition for a given ownership structure; and Section 4 applies the results to typical common ownership structures. In Section 5, we add a previous stage to the game presented in Section 2 to analyze the incentives to form common ownership arrangements. Section 6 discusses the results and concludes.

2 Model

There are $N \geq 2$ identical firms and I investors, such that $I \geq N$. We let j and k index firms, and i index investors. Each firm is owned by investors with financial stakes with potentially different degrees of control. Denote α_{ij} as the share of firm j owned by investor i that entails financial rights to this investor. We write α_j $(= \alpha_{jj})$ as the shares of firm j retained by investor $i = j$. We also allow for minority (non-controlling) shareholders and introduce z_j as the fraction of firm j's profit owned by them. Then $z_j = 1 - \sum_i^I \alpha_{ij}$ with $0 \leq z_j < 1$, and $\alpha_j = 1 - z_j - \sum_{i \neq j}^I \alpha_{ij}$.[6]

Following Salop and O'Brien (2000) we allow for different corporate control structures by introducing the parameter γ_{ij}, which captures the extent of investor i's control over

[6] We assume that minority shareholders do not exert their voting rights because their control is relatively negligible and face coordination problems. See Azar et al. (2018).

firm j. Thus, $\sum_i^I \gamma_{ij} = 1$ for any j.

For a given common ownership structure (hereafter CO), firms compete à la Bertrand with homogeneous goods. Firms have the same constant marginal production cost, c, and each firm j sets a price, p_j. The firms with the lowest price, p, split the demand, $Q(p)$, equally. Assume that $Q(p)$ is smooth and strictly downward sloping when positive. For a given quantity q sold by firm j, its operating profit is $\pi_j = (p - c)q$. Investor i's total (portfolio) profit is $\pi^i = \sum_k^N \alpha_{ik}\pi_k$, where π_k is firm k's profit. Given the existing COs, the manager of firm j maximizes a weighted average of the investors' portfolio profits:

$$\sum_i^I \gamma_{ij}\pi^i = \left(\sum_i^I \gamma_{ij}\alpha_{ij}\right)\pi_j + \sum_i^I \gamma_{ij}\sum_{k\neq j}^N \alpha_{ik}\pi_k.$$

For manager of firm j, maximizing the above expression is equivalent to maximizing the objective function

$$\Pi_j = \pi_j + \sum_{k\neq j}^N \lambda_{jk}\pi_k, \text{ where } \lambda_{jk} \equiv \frac{\sum_i^I \gamma_{ij}\alpha_{ik}}{\sum_i^I \gamma_{ij}\alpha_{ij}}. \quad (1)$$

The manager of firm j internalizes the profit of firm k through parameter λ_{jk}, which is the relative weight that the manager of j places on k's profit in relation to the profit of firm j. Parameter λ_{jk} captures the control of firm j by investors with stakes in both firms j and k.

3 Price Competition

In this section, we study price competition for a given ownership structure. For given prices, let $p = \min\{p_j\}_{j=1}^N \leq p^M$, where p^M is the monopoly price. Let L and Ω be the number and set of firms with the lowest price, respectively. The general expression for the objective of firm j's manager is

$$\Pi_j = (p - c)\frac{Q(p)}{L} + \sum_{k\in\Omega\setminus\{j\}}^N \lambda_{jk}(p - c)\frac{Q(p)}{L} \text{ if } p_j = p, \text{ and}$$

$$\Pi_j = \sum_{k\in\Omega\setminus\{j\}}^{N} \lambda_{jk}(p-c)\frac{Q(p)}{L} \text{ if } p_j > p.$$

Next, we study equilibria with positive profits by focusing on candidate equilibria where all firms set the same price. A necessary condition for an equilibrium with positive profit and where all the firms set the same price is

$$(p-c)Q(p) \leq (p-c)\frac{Q(p)}{N} + \sum\nolimits_{k\neq j}^{N} \lambda_{jk}(p-c)\frac{Q(p)}{N}.$$

This condition implies that the internalized profit from undercutting the price must be at most equal to the internalized profit from keeping the same price as the other firms.[7] By simplifying we obtain

$$1 \leq \frac{\sum_{k\neq j}^{N} \lambda_{jk}}{N-1}. \tag{2}$$

Hence, the weight that firm j's manager gives on firm j must be smaller or equal to the average weight in all other firms.

For a given price to be an equilibrium we need managers to have neither incentives to undercut the minimum (common) price nor to deviate from it by setting a higher price. The rationale of the latter is to exit the market and simply enjoy profits through the participations in other firms. Hence, the following condition needs to be satisfied

$$\sum\nolimits_{k\neq j}^{N} \lambda_{jk}(p-c)\frac{Q(p)}{N-1} \leq (p-c)\frac{Q(p)}{N} + \sum\nolimits_{k\neq j}^{N} \lambda_{jk}(p-c)\frac{Q(p)}{N}.$$

This condition states that the internalized profit from setting a price higher than the candidate equilibrium price (which consists of j's investors participations in rivals' profit) must be at most equal to the internalized profit from setting the same price as rivals (which includes own firm's profit plus the investors participations in the other firms' profits). After some rearrangements, the condition reduces to

$$\frac{\sum_{k\neq j}^{N} \lambda_{jk}}{N-1} \leq 1. \tag{3}$$

[7]This is true as long as $p \leq p^M$, which is assumed, otherwise managers have incentives to return to the monopoly price.

Intuitively, by raising the price, firm j allows the other $N-1$ firms enjoy higher profits because they share the industry profit with one firm less. This is more attractive for j's manager the higher $\sum_{k\neq j}^{N} \lambda_{jk}$ becomes. On the other hand, by setting the same price as rivals, firm j enjoys an additional share of profit. This is more attractive the lower $\sum_{k\neq j}^{N} \lambda_{jk}$ becomes, that is, the less manager j weighs the profit of other firms in relation to the own firm's profit.

Note that λ_{jk} increases with the control over firm j exercised by investors with high stakes in firm k (high γ_{ij} along with high α_{ik} increases the numerator $\sum_{i=1}^{I} \gamma_{ij}\alpha_{ik}$) and as the ownership concentration and control of firm j diminishes (i.e., as the denominator $\sum_{i=1}^{I} \gamma_{ij}\alpha_{ij}$ decreases).

In both (2) and (3) the term $(p-c)Q(p)$ cancels out, meaning that the level of prices – and therefore quantities – plays no role in these conditions. Conditions (2) and (3) lead to the following proposition.

PROPOSITION 1 *In Bertrand competition with symmetric costs and homogeneous products, there exists a continuum of equilibria with positive profits and a common price, p, such that $c < p \leq p^M$ if the following condition is fulfilled for each firm $j = 1, 2, ..., N$:*

$$\sum_{k\neq j}^{N} \lambda_{jk} = N - 1. \tag{4}$$

If this condition is not fulfilled, then the only common price equilibrium is marginal cost pricing.

If system (4) is fulfilled, no firm has an incentive to deviate from the common price, and any price between c and monopoly price can be an equilibrium. Importantly, note that system (4) encompasses general CO and control structures that we illustrate in Section 4.

For a given corporate control, Proposition 1 states that the higher the number of other firms, the higher the total stakes that investors must own of these in order to deter deviations from the common price. The reason is that the incentives to deviate increase with the number of firms as the equilibrium profit obtained by each single firm shrinks.

In order to make firms' managers unwilling to deviate, they must give more weight to other firms' profits. This can happen when investors own a higher fraction of *total* other firms' shares so that each manager internalizes less of her own firm's profits and more of other firms' profits.[8]

To illustrate that any common price $p \in (c, p^M]$ is an equilibrium, Figure 1 shows firm j's manager objective function (Π_j) as a function of p_j when the rest $N-1$ firms set the price at $p^* \in (c, p^M)$ and (4) holds.

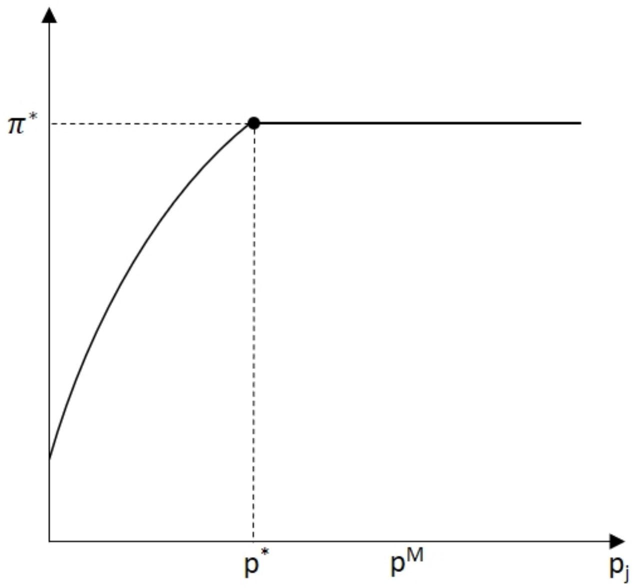

Figure 1: Firm j's manager objective function when $p_k = p^*$ for $k \neq j$.

Because products are homogeneous, if $p_j < p^*$, firm j captures the whole market, then $\Pi_j = \pi(p_j)$, which is increasing in p_j for $p_j < p^*$ since $p^* < p^M$. Notice that the maximum is achieved at $\pi^* = \pi(p^*) = (p^* - c)Q(p^*)$. If $p_j = p^*$, then $\Pi_j = (p^* - c)\frac{Q(p^*)}{N} + \sum_{k \neq j}^{N} \lambda_{jk}(p^* - c)\frac{Q(p^*)}{N}$. Under (4), $\sum_{k \neq j}^{N} \lambda_{jk} = N - 1$, thus $\Pi_j = \pi^*$. If, however, $p_j > p^*$, then, once again because products are homogeneous,

$$\Pi_j = \sum_{k \in \Omega \setminus \{j\}}^{N} \lambda_{jk}(p^* - c)\frac{Q(p^*)}{N - 1},$$

and by inserting the condition $\sum_{k \neq j}^{N} \lambda_{jk} = N - 1$ into the above expression we get

[8] A higher fraction of total firms' shares may come from a higher share that each investor has in other pre-existing firms, or a higher share in the new firms similar to the share each has in the pre-existing firms.

$\Pi_j = (p^* - c)Q(p^*) = \pi^*$. Therefore, firms have no incentives to deviate from p^*: any price deviation with $p_j < p^*$ decreases Π_j, whereas any price p_j above p^* will not increase Π_j.

One special case of interest is when the ownership concentration of firm k measured by the sum $\sum_{i=1}^{I} \gamma_{ij}\alpha_{ik}$ (i.e., the numerator of λ_{jk}) is equal to the ownership concentration and control of firm i measured by the sum $\sum_{i=1}^{I} \gamma_{ij}\alpha_{ij}$ (i.e., the denominator of λ_{jk}) for all $j \neq k$, then $\lambda_{jk} = 1$ and Proposition 1 holds for all j. So, the next corollary follows.

COROLLARY 1 *The CO structures that satisfy* $\sum_{i=1}^{I} \gamma_{ij}\alpha_{ik} = \sum_{i=1}^{I} \gamma_{ij}\alpha_{ij}$ *for all* $j \neq k$ *support price equilibria with positive profits and with symmetric and asymmetric COs.*

If the (control-weighted) share of profits that investors have in one firm is equal to the (control-weighted) share of profits in all other firms, then no manager has an incentive to deviate.

Another special case of Proposition 1 is when each investor holds the same financial interests in each firm. Then Corollary 2 follows.

COROLLARY 2 *For any control structure and any* z_i*, if* $\alpha_{ij} = \alpha_i$ *for all* i *(with* $\alpha_i = \alpha$ *in the symmetric example), then firms' managers maximize industry profits and condition (4) holds.*

This is because when $\alpha_{ij} = \alpha_i$ for all i, then we can rewrite the investor i's portfolio profit as

$$\pi^i = \sum_{j=1}^{N} \alpha_{ij}\pi_j = \sum_{j=1}^{N} \alpha_i \pi_j = \alpha_i \sum_{j=1}^{N} \pi_j,$$

and then Corollary 2 follows.[9]

The next subsection applies our main results to typical CO structures.

4 Applications to Typical CO Structures

Proportional control (one share, one vote) represents approximately 9 in 10 of the public US corporations. However, in recent years there has been a growth in the number of

[9] We thank one referee for pointing us this valuable result.

corporations that go public with structures that lack proportionality between ownership and control (in the first half of 2021 in the US, 24% of the companies that went public differed from the one share, one vote structure) (Council of Institutional Investors, 2022).

For the illustrative examples, we set $N = I = 3$ and define matrix $A = (\alpha_{ij}) \in R^{3\times 3}$. Thus, row $i \in \{1, 2, 3\}$ represents stakes of investor i, whereas column $j \in \{1, 2, 3\}$ represents investors' stakes on firm j. Analogously, we define matrices $\Gamma = (\gamma_{ij}) \in R^{3\times 3}$ and $\Lambda = (\lambda_{ij}) \in R^{3\times 3}$. Furthermore, let $\bar{z}_j \equiv (1-z_j)$ be the fraction of shares of each firm j owned by controlling investors, and to simplify the exposition assume that $z_j = z \geq 0$ for all j.

Next, we present first examples of the main case (proportional control), and then examples of non-proportional control configurations, including silent financial interests.

4.1 Proportional Control

In the case of proportional control, managers maximize their shareholders' portfolios taking control interests in proportion to financial interests: $\gamma_{ij} = \alpha_{ij}/(1 - z_j)$ for all i, j. We consider two examples with symmetric and asymmetric CO configurations.

Example 1. This example illustrates a symmetric CO configuration that admits price equilibria with positive (even monopoly) profit with $\alpha_{ij} = \bar{z}/3$, which implies that $\gamma_{ij} = 1/3$ for all i, j. It follows that $\lambda_{jk} = 1$ for all $j \neq k$.

Here $\sum_{i=1}^{I} \gamma_{ij}\alpha_{ik} = \sum_{i=1}^{I} \gamma_{ij}\alpha_{ij}$, thus Corollary 1 and therefore Proposition 1 hold. Notice that the existence of minority shareholders facilitates the monopoly outcome: investors need to own a lower proportion of rivals' shares to sustain the monopoly price. The intuition is that, with minority shareholders, the manager of firm j weighs firm j's profits less, and therefore investors need to own a lower proportion of the other firms to keep the common price.

The next example presents a case of proportional control with an asymmetric configuration (in terms of ownership) that satisfies (4).

Example 2. Let $z_j = 0$ for all j, and

$$A_2 = \Gamma_2 = \begin{pmatrix} 0.6 & 0.6 & 0.6 \\ 0.2 & 0.2 & 0.2 \\ 0.2 & 0.2 & 0.2 \end{pmatrix}.$$

In this example, investor 1 is the major shareholder of the three firms owning (and having control for) 60% of each of them, whereas investors 2 and 3 own and control 20% of each firm. Notice that $\lambda_{jk} = 1$ for all j, k.[10]

The next subsection includes examples of other non-proportional control structures, such as multiple classes of shares and silent financial interests.

4.2 Non-proportional control structures

4.2.1 Multiple classes of shares

In this sub-section we consider cases that include more than one type of shares with different voting rights.

Example 3. Using the Corollary 2, consider the following structure with $z_j = 0$ for all j:

$$A_3 = \begin{pmatrix} 0.45 & 0.45 & 0.45 \\ 0.05 & 0.05 & 0.05 \\ 0.5 & 0.5 & 0.5 \end{pmatrix}, \qquad \Gamma_3 = \begin{pmatrix} 0.45 & 0 & 0.45 \\ 0.05 & 0.5 & 0.05 \\ 0.5 & 0.5 & 0.5 \end{pmatrix}.$$

Firms 1 and 3 have one share, one vote classes of shares, while firm 2 has three classes of shares. In firm 2, investor 1 owns shares with no control rights, whereas investor 2 owns supravoting shares with 10 votes per share, and investor 1 owns the typical one share, one vote share type.[11] Example 3 satisfies (4) with $\lambda_{jk} = 1$ for all j, k.

The assumption $\alpha_{ij} = \alpha_i$ for all i is not necessary for Proposition 1 to hold as shown

[10] To illustrate this case with the presence of non-controlling shareholders, consider $\bar{z} = 0.3$. Then the matrix of financial interests is equal to $\bar{z}A_2$ and it satisfies (4) with $\lambda_{jk} = 1$ for all j, k. With 70% of the shares owned by minority shareholders, investor 1 owns 18% of each firm and controls 60% of the votes in each of them, while investors 2 and 3 own 6% of each firm and control 20%.

[11] The example of firm 2 is inspired by the similar three classes of shares that Alphabet Inc.(Google) has.

in the following illustrative example.

Example 4. The matrices below define an asymmetric ownership-control structure and satisfy condition (4) of Proposition 1:

$$A_4 = \begin{pmatrix} 0.4 & 0.35 & 0.25 \\ 0.25 & 0.4 & 0.35 \\ 0.35 & 0.25 & 0.4 \end{pmatrix}, \qquad \Gamma_4 = \begin{pmatrix} 1/15 & 2/15 & 6/15 \\ 3/15 & 7/15 & 2/15 \\ 11/15 & 6/15 & 7/15 \end{pmatrix}.$$

Each firm has three classes of shares with different voting rights: some shares confer infra-voting rights (with less than one vote per share), while others supra-voting rights (with more than one vote per share). Notice that the relative weights that the manager of j places of firm k's profit in relation to the profit of firm j can be summarized as

$$\Lambda_4 = \begin{pmatrix} 1 & 0.86 & 1.14 \\ 0.93 & 1 & 1.07 \\ 1.07 & 0.93 & 1 \end{pmatrix}.$$

Therefore, and unlike the previous examples, with this configuration the managers of each firm do not weight equally the profits of each firm.

4.2.2 Silent Financial Interests

With silent financial interests, an investor of each firm j (which we refer to as investor $i = j$) has total control over it, thus: $\gamma_{jj} = 1$ and $\gamma_{ij} = 0$ for $i \neq j$. Then, Proposition $1's$ condition reduces to $\alpha_j = \frac{\beta_j}{(N-1)}$, where $\beta_j = \sum_{k \neq j}^{N} \alpha_{jk}$ corresponds to the sum of the stakes that the controlling investor of firm j has on the rest of firms. Any price between c and the monopoly price can be an equilibrium provided that the share α_j of j's controlling shareholder in firm j is equal to the average stake that she has in other firms, $\beta_j/(N-1)$. When this condition holds, the shareholder neither wishes to undercut all the rivals, in which case she would get a share α_j of the industry profit, $(p-c)Q(p)/N$, nor to raise the price, in which case the industry profit would be captured by the $N-1$ rivals in which she has the average stake of $\beta_j/(N-1)$.

Example 5. The symmetric CO configuration $\alpha_{ij} = \bar{z}/3$ for all i, j with $\lambda_{jk} = 1$ for all j, k, satisfies Proposition 1. This means that, with silent financial interests, when each investor has the same share of every firm, no manager has an incentive to deviate.

5 Incentives to Form CO Structures

Most of the extant literature has examined price or quantity equilibria for a given ownership structure but has omitted the discussion on whether such ownership structure is itself an equilibrium. Flath (1991) makes a first approximation to this problem in a model of cross-ownership, where firms (not investors) acquire stakes in rival firms. Flath's analysis focuses on the impact of acquiring rival's shares on the payoff of each firm, and assumes that share prices equal the post-trade product market equilibria. This assumption is restrictive: all that matters is that for a given trade, the joint profit of the two involved firms increases. This observation is also made in Reitman (1994) that explores the impact of partial ownership arrangements on joint profit maximization in a conjectural variations model.

We address the issue of whether an ownership structure supporting the price equilibrium of Proposition 1 is an equilibrium ownership structure of an extended game. We introduce a previous stage to the analyzed game in the previous section in which the investor(s) of each firm can strategically acquire rival firms' shares and/or sell her own shares under a given corporate control structure and a mass of exogenous minority shareholders. Since investors are strategic, they have incentives to form ownership arrangements that support positive profits. There are however many possible distributions of the total industry profit among investors depending on the ownership configuration.

We explore two possibilities that account for investors' individual incentives and support the price equilibrium of Proposition 1 as an equilibrium in ownership structure of the extended game: (i) a network formation game with transfers among investors; (ii) a Nash bargaining game among investors.

The two-stage game is solved by backward induction. Thus, we have to determine at what equilibrium price firms will coordinate on at the pricing stage. We resolve this issue by assuming that in any subgame, firms will play the Pareto superior equilibrium, which is the payoff dominant equilibrium. This is in line with Harsanyi (1964), Harsanyi and Selten (1988) and Fudenberg and Tirole (1983), which point out that it is reasonable to expect that rational players will select the payoff dominant equilibrium. In our game, when (4) holds, there is a unique payoff dominant equilibrium: the monopoly price. Our analysis thus proceeds with the monopoly price as the selected price equilibrium when (4) holds at the pricing stage.

5.1 Network formation game

A network formation game is suited to study the formation of stable ownership structures because it captures the idea that if two players benefit from forming a particular link then we should expect them to coordinate on forming such a link.[12] An equilibrium concept that captures mutual consent is pairwise stability, which can be extended to include transfers among players (Jackson and Wolinsky, 1996; Bloch and Jackson, 2006):

Definition 1 *(Pairwise stability with transfers). Let $u^j(g)$ be the payoff to player j under network g, and let xy denote the link between player x and player y. The term $xy \in g$ indicates that x and y are linked in the network g. Such a network is said to be pairwise stable with transfers if*

$$(i)\ xy \in g \Rightarrow\ u^x(g) + u^y(g) \geq u^x(g - xy) + u^y(g - xy),\ \textit{and}$$
$$(ii)\ xy \notin g \Rightarrow\ u^x(g) + u^y(g) \geq u^x(g + xy) + u^y(g + xy).$$

Thus, we say that a network is pairwise stable if no player has incentives to sever a formed link and moreover no two players want to create a new link. The first condition gives players the unilateral discretion to remove non-profitable links, whereas the second condition captures the idea that the formation of a link requires mutual consent. We

[12] In a Nash equilibrium of a simultaneous announcement model, two players may benefit from forming a link and still it may be an equilibrium not to form such a link.

next show that the ownership structure given by (4) satisfies these two conditions.[13]

We first reformulate the conditions in terms of an ownership structure formation game. To that end, we let A_j be the vector of stakes of firm j owned by all investors $i \neq j$: $A_j = [\alpha_{j1,}\alpha_{j2}, .., \alpha_{j-1}, \alpha_{j+1}, .., \alpha_{jN}] \in [0,1]^{N-1}$, and $A = A_1 \times \cdots \times A_N$ be the Cartesian product of A_j, and therefore the space of stakes of the game. The ownership structure of this market is characterized by $a = (a_1, ..., a_N) \in A$, where $a_j \in A_j$.

Consider the owners x and y, and define $\pi^i(a + \alpha)$ and $\pi^i(a - \alpha)$ as the payoff of investor i when the stake $\alpha > 0$ is traded and removed respectively. If the stake is not traded then $\alpha = 0$. An ownership structure a^* is pairwise stable if

$$(i') \ \alpha^* > 0 \ \Rightarrow \ \pi^x(a^*) + \pi^y(a^*) \geq \pi^x(a^* - \alpha) + \pi^y(a^* - \alpha)$$

with $\alpha \leq \alpha^*$, i.e., investors x and y trade a given stake only when such a trade raises their joint profit, and if

$$(ii') \ \alpha^* = 0 \ \Rightarrow \pi^x(a^*) + \pi^y(a^*) \geq \pi^x(a^* + \alpha) + \pi^y(a^* + \alpha)$$

for any feasible positive α, i.e., the trade of stake α does not take place when it lowers the joint profit of the two corresponding investors. Note however that when (4) is satisfied we have that

$$\pi^i = \left[(1 - z_i - \textstyle\sum_{k\neq i}^{N} \alpha_{ki}) + \textstyle\sum_{k\neq i}^{N} \alpha_{ik}\right] \pi_M / N, \tag{5}$$

where π_M is the monopoly profit, and therefore the sum $\pi^x + \pi^y$ is independent of α. For a given mass of minority shareholders, $z_1, ...z_N$, we have the following result.

PROPOSITION 2 *Assuming that the payoff dominant equilibrium is selected at the pricing stage, any configuration a^* that satisfies (4) is pairwise stable for any given corporate control structure.*

[13] There are other stability concepts such as the pairwise Nash equilibrium and strong stability concepts. However, as pointed out in Jackson (2008, p.156), the concept of pairwise stability provides tight predictions about the formation of stable networks with no need of examining richer deviations.

Notice that each firm makes the symmetric payoff π_M/N in the payoff dominant equilibrium, and trading or removing a stake of size α just changes the distribution of the joint profit between the two investors but does not increase its size. It does, however, decrease the joint profit if, as a result of such a deviation, Proposition 1 no longer holds, in which case $\pi^x + \pi^y$ will equal zero due to reversal to marginal cost pricing.

5.2 Bargaining game

In this section we study the acquisition of stakes by considering a bargaining process that determines how investors share total industry profits.[14] As in the network formation game, we consider the payoff dominant equilibrium as the selected equilibrium in the second stage.

Suppose that prior to the bargaining, each investor i is endowed with an exogenous bargaining power σ_i, with $\Sigma_i \sigma_i = 1$.[15] Then each i obtains

$$\psi^i \equiv \sigma_i \pi_M [1 - \textstyle\sum_k^N z_k/N], \tag{6}$$

that is, investors bargain over the (industry) monopoly profit minus the corresponding fraction distributed among minority shareholders: since each firm obtains π_M/N, firm j's minority shareholders receive $z_j \pi_M/N$.

At the payoff dominant equilibrium the total (portfolio) profit of investor i is $\pi^i = \sum_k^N \alpha_{ik}\pi_M/N$. Then, it must hold that $\sum_k^N \alpha_{ik}\pi_M/N = \psi^i$ for each investor i. It follows that:

PROPOSITION 3 *Assuming that the payoff dominant equilibrium is selected at the pricing stage, the ownership structure that satisfies (4) is the result of a bargaining game with*

[14] The possibility that ownership structures arise from a bargaining process has been studied, for example, in Ghosh and Morita (2017), that consider the bargaining between two firms to determine the level of ownership of one of them in the equity of the other.

[15] This is the standard $n-$person (asymmetric) Nash bargaining solution with disagreement payoffs equal to zero of the bargaining over the partition of a cake problem. See Muthoo (1999, pp. 35-36) and Binmore (1992, pp. 180-191).

the following distribution of bargaining power among investors:

$$\sigma_i = \frac{\sum_k^N \alpha_{ik}/N}{[1 - \sum_k^N z_k/N]}. \tag{7}$$

Hence, the distribution of bargaining power among investors must be equal to the ratio of the average stake in all firms owned by a given investor over the average fraction of non-minority shares in each firm.

Also, the condition in Proposition 1 must hold for each firm j. Thus, the ownership structure satisfying (4) and (7) yields ψ^i for each investor i.[16] Next, we show the ownership and bargaining power configurations that satisfy these conditions in some examples presented in Section 4.

In Example 2 with proportional control, $z_k = 0$, $\sum_k^N \alpha_{1k}/N = 0.6$, $\sum_k^N \alpha_{2k}/N = 0.2$ and $\sum_k^N \alpha_{3k}/N = 0.2$, thus from (7) we have that $\sigma_1 = 0.6$, $\sigma_2 = 0.2$ and $\sigma_3 = 0.2$.

In Example 3 with multiple classes of shares, we have that $\sum_k^N \alpha_{1k}/N = 0.45$, $\sum_k^N \alpha_{2k}/N = 0.05$ and $\sum_k^N \alpha_{3k}/N = 0.5$. Since $z_k = 0$, from (7) we obtain $\sigma_1 = 0.45$, $\sigma_2 = 0.05$ and $\sigma_3 = 0.5$.

In Example 5 with silent financial interests and symmetric CO, we obtain $\sigma_i = 1/3$ for $i = 1, 2, 3$.

6 Discussion and Conclusion

This paper has studied Bertrand competition with symmetric costs and homogeneous products in the presence of common ownership. We find that the monopoly outcome can be achieved through common ownership since this helps to remove the incentives to deviate. We characterize the ownership and corporate control structures that support common price equilibria with positive profits, and show that they admit both symmetric and asymmetric stakes. Furthermore, we show that the common ownership structures supporting the monopoly outcome can arise as the solution to a network formation game

[16] The amount of total payoffs is fixed and its existence depends on Proposition 1 being satisfied. While a new trade may make Proposition 1 not fulfilled, different distributions of bargaining power do not affect this condition.

or a bargaining problem among investors.

Our results apply to various corporate control structures: proportional control, non-proportional control, which includes multiple classes of shares and silent financial interest, and any number of firms. We find that the higher the number of other firms, the higher the total stakes that investors must own of these in order to deter firms' managers from deviating in the price competition stage. Conversely, the higher the proportion of minority shareholders with no control rights, the lower the stakes of other firms that investors must own to maintain the monopoly outcome.

A possible extension to our paper would be to check the robustness of our results for alternative formulations to represent shareholder influence on the manager's objective function. We have followed Rotemberg (1984), Bresnahan and Salop (1986), and Salop and O'Brien (2000), which has been microfounded through a voting model in which shareholders vote to elect the manager (see Azar 2012; Brito et al. 2018; and Moskalev 2019). This model is the main one used in the common ownership literature (see, for example, Azar et al. 2018, and Schmalz 2018). However, this approach has been criticized for yielding seemingly counter-intuitive predictions about profit weights when the common owners become dispersed (see, for example, Crawford et al., 2018; Gilje et al. 2018; Azar and Ribeiro, 2021).[17]

Our paper shows that firms can achieve the monopoly outcome even in an environment of strong competition, such as in Bertrand with homogeneous products. As a result, competition authorities should be highly suspicious of the existence of financial links in an industry.[18] This suggests that competition authorities need to have more detailed knowledge of the network of ownership stakes among investors to estimate the potential anticompetitive effects of common ownership.

[17]For excellent discussions on these issues, see Backus et al. (2021a) and Brito et al. (2021).

[18]This is particularly necessary in the absence of externalities (López and Vives, 2019).

References

[1] Anton, M., Ederer, F., Gine, G., and Schmalz, M. C. (2020). Common ownership, competition, and top management incentives. European Corporate Governance Institute (ECGI) - Finance Working Paper No. 511/2017.

[2] Appel, I.R., Gormley, T.A., and Keim, B. (2016). Passive investors, not passive owners. Journal of Financial Economics, 121(1), 111-141.

[3] Azar, J. (2011). A new look at oligopoly: Implicit collusion through portfolio diversification. Available at SSRN 1993364.

[4] Azar, J. (2012). A new look at oligopoly: Implicit collusion through portfolio diversification. PhD thesis, Princeton University.

[5] Azar, J., and Schmalz, M. C. (2017). Common ownership of competitors raises antitrust concerns. Journal of European Competition Law & Practice, 8(5), 329-332.

[6] Azar, J., Schmalz, M. C., and Tecu, I. (2018). Anti-competitive effects of common ownership. The Journal of Finance, 73(4), 1513-1565.

[7] Azar, J., and Ribeiro, R. M. (2021). Estimating Oligopoly with Shareholder Voting Models. Available at SSRN 3988265.

[8] Backus, M., Conlon, C., and Sinkinson, M. (2021a). Common ownership in America: 1980−2017. American Economic Journal: Microeconomics, 13(3), 273-308.

[9] Backus, M., Conlon, C., and Sinkinson, M. (2021b). Common ownership and competition in the ready-to-eat cereal industry (No. w28350). National Bureau of Economic Research.

[10] Bayona, A., and López, Á. L. (2018). Silent financial interests and product innovation. Economics letters, 170, 109-112.

[11] Bebchuk, L. A., Cohen, A., and Hirst, S. (2017). The agency problems of institutional investors. Journal of Economic Perspectives, 31(3), 89-102.

[12] Bernheim, B. D., and Madsen, E. (2017). Price cutting and business stealing in imperfect cartels. American Economic Review, 107(2), 387-424.

[13] Binmore, K. (1992). Fun and Games. D.C. Heath and Company, Lexington, Massachusetts.

[14] Bloch, F., and Jackson, M. (2006). Definitions of equilibrium in network formation games. International Journal of Game Theory 34: 305-318.

[15] Bresnahan, T. F., and Salop, S. C. (1986). Quantifying the competitive effects of production joint ventures. International Journal of Industrial Organization, 4(2), 155-175.

[16] Brito D., Ribeiro R., and Vasconcelos H. (2018). Quantifying the coordinated effects of partial horizontal acquisitions. European Economic Review, 110, 108-149.

[17] Brito, D., Elhauge, E., Ribeiro, R. M., and Vasconcelos, H. (2021). Modelling the objective function of managers in the presence of overlapping shareholding. Available at SSRN 3264113.

[18] Council of Institutional Investors, (2022, February 13). Dual-class stock. Available at https://www.cii.org/dualclass_stock.

[19] Crawford G. S., Lee R.S., Whinston M.D., and Yurukoglu A., (2018). The welfare effects of vertical integration in multichannel television markets. Econometrica, 86 (3), 891-954.

[20] Farrell, J., and Shapiro, C. (1990). Asset ownership and market structure in oligopoly. The RAND Journal of Economics, 21(2), 275-292.

[21] Flath, D. (1991). When is it rational for firms to acquire silent interests in rivals?. International Journal of Industrial Organization, 9(4), 573-583.

[22] Foros, O., Kind, H.J., and Shaffer, G. (2011). Mergers and partial ownership. European Economic Review, 55, 916-926.

[23] Fudenberg, D., and Tirole, J. (1983). Capital as a commitment: strategic investment to deter mobility. Journal of Economic Theory, 31, 227-250.

[24] Gilje, E. P., Gormley, T. A., and Levit, D. (2020). Who's paying attention? Measuring common ownership and its impact on managerial incentives. Journal of Financial Economics, 137(1), 152-178.

[25] Gilo, D., Moshe, Y., and Spiegel, Y., (2006). Partial cross ownership and tacit collusion. The RAND Journal of Economics, 37(1), 81-99.

[26] Ghosh, A., and Morita, H. (2017). Knowledge transfer and partial equity ownership. The RAND Journal of Economics, 48(4), 1044-1067.

[27] Harsanyi, J.C. (1964). A general solution for finite noncooperative games, based on risk dominance. In Dresher, M. et al. (eds.) Advances in Game Theory, Annals of Mathematics, Study 52, Princeton, pp. 627-650.

[28] Harsanyi J. C., and Selten R., (1988). A General theory of equilibrium selection in Games, MIT Press.

[29] He, J. J., and Huang, J. (2017). Product market competition in a world of cross-ownership: Evidence from institutional blockholdings. The Review of Financial Studies, 30(8), 2674-2718.

[30] Jackson, M. O., and Wolinsky, A. (1996). A strategic model of social and economic networks. Journal of Economic Theory, 71(1), 44-74.

[31] Jackson, M. (2008). Social and economic networks. Princeton; Oxford: Princeton University Press.

[32] Koch, A., Panayides, M. and Thomas, S. (2021). Common ownership and competition in product markets. Journal of Financial Economics, 139(1), pp.109-137.

[33] Lewellen, K., and Lowry, M. (2021). Does common ownership really increase firm coordination?. Journal of Financial Economics, 141(1), 322-344.

[34] López, Á. L., and Vives, X. (2019). Overlapping ownership, R&D spillovers, and antitrust policy. Journal of Political Economy, 127(5), 2394-2437.

[35] Moskalev, A. (2019). Objective function of a non-price-taking firm with heterogeneous shareholders. Available at SSRN 3471564.

[36] Nain, A., and Wang, Y. (2018). The product market impact of minority stake acquisitions. Management Science, 64(2), 825-844.

[37] Muthoo, A. (1999). Bargaining theory with applications. Cambridge University Press.

[38] O'Brien, D. P., and Waehrer, K. (2017). The competitive effects of common ownership: We know less than we think. Antitrust Law Journal, 81, 729.

[39] Papadopoulos, K. G., Petrakis, E., and Skartados, P. (2019). Product innovation transfer under passive partial ownership holdings. Economics Letters, 177, 22-25.

[40] Park, A. H., and Seo, K., (2019). Common ownership and product market competition: evidence from the U.S. airline industry. Korean Journal of Financial Studies, 48, 617.

[41] Posner, E. A., Scott Morton, F. M., and Weyl, E. G. (2017). A proposal to limit the anti-competitive power of institutional investors. Antitrust Law Journal, 81(3).

[42] Reitman, D. (1994). Partial ownership arrangements and the potential for collusion. The Journal of Industrial Economics, 42(3), 313-322.

[43] Reynolds, R. J., and Snapp, B. R. (1986). The competitive effects of partial equity interests and joint ventures. International Journal of Industrial Organization, 4(2), 141-153.

[44] Rotemberg J. 1984. Financial transaction costs and industrial performance. Working Paper, Sloan School Management, Massachusetts Institute of Technology, Cambridge

[45] Salop, S. C., and O'Brien, D.P. (2000). Competitive effects of partial ownership: Financial interest and corporate control. Antitrust Law Journal, 67(3), 559-614.

[46] Schmalz, M. C. (2018). Common-ownership concentration and corporate conduct. Annual Review of Financial Economics, 10, 413-448.

[47] Shelegia, S., and Spiegel, Y. (2012). Bertrand competition when firms hold passive ownership stakes in one another. Economics Letters, 114(1), 136-138.

[48] Sugaya, T., and Wolitzky, A. (2018). Maintaining privacy in cartels. Journal of Political Economy, 126(6), 2569-2607.