Common Ownership, Corporate Control and Price Competition*

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

February 2021

Abstract

We examine price competition with homogeneous products in the presence of general common ownership arrangements allowing for different corporate control structures. Common ownership leads managers to internalize other firms' profits. 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 Joseph Harrington and Sjaak Hurkens 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.

†Corresponding author: 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, Departament d'Economia Aplicada, Universitat Autònoma de Barcelona, 08193 Bellaterra (Barcelona, Spain) and Public-Private Sector Research Center, IESE Business School. Tel. +34 935 811 528. E-mail address: angelluis.lopez@uab.cat

§Anton-Giulio Manganelli, EADA Business School, C. d'Aragó, 204, 08011 Barcelona (Spain) and CRES, Universitat Pompeu Fabra, C. Ramon Trias Fargas, 25-27, 08005 Barcelona. E-mail address: amanganelli@eada.edu

1 Introduction

The phenomenon of common investors in firms from the same industry is widespread. These external common investors include investment managers, conglomerate holding companies, pension and hedge funds, among others. The industries in which common ownership is prevalent are technology, pharmaceuticals, banks, agrifood, and airlines.[1] There is evidence that 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). Backus et al. (2020) 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.[2]

The academic literature has shown that in general, horizontal overlapping ownership structures reduce competition, however, there is limited 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 the research questions in a model where a finite number of symmetric firms compete à la Bertrand with homogeneous goods.[3] We focus on a general framework that allows for different degrees of control, and which encompasses two typical examples of common ownership as special cases: (i) *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

[1] See, for example, Azar et al. (2018) and Clapp (2019).

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

[3] 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).

acquisition of a financial interest which is too small to have effective decision rights. This case arises in industries where venture capitalists are prevalent common investors (see, for example, Eldar et al. 2020); (ii) *proportional control*, where managers take investors' control interests in proportion to their financial interests.[4] This structure resembles the case of mutual and hedge funds as common investors in many industries (see, for example, Schmalz 2018), and more generally, it approximates the case of institutional investors.[5]

The manager of a firm maximizes a weighted average of the investors' portfolio profits given the existing common ownership structure.[6] 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 among investors and in a Nash bargaining process among investors.

We find that, with common ownership, 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 is equal to the profits from maintaining the common price. Our analysis show that common price equilibria with positive profits can be supported by both symmetric and asymmetric common ownership structures.

We find that the higher the number of firms, the higher the stakes that investors must own of other firms to deter firms 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 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. The way to avoid deviations is to have investors own a higher fraction of other firms' shares, so that each manager internalizes less of her own

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

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

[6]Salop and O'Brien (2000, Appendix C) develop the model of shareholder influence on the manager's objetive function. See also Azar et al. (2018) and López and Vives (2019, Appendix A).

firm's profits and more of other firms' profits.

Previous theoretical work has shown that horizontal overlapping ownership arrangements generally reduce competition (Rotemberg 1984; Bresnahan and Salop 1986; Reynolds and Snapp 1986; Farrell and Shapiro 1990; Salop and O'Brien 2000). The main message of this literature is that, when a firm (say firm 1) buys a share of another firm (say firm 2), competition will be less intense for two reasons. First, aggressive behavior of firm 1 will negatively affect firm 2, therefore reducing firm 1's total profits through its participation in 2. This effect arises solely because of firm 1's financial interest in firm 2, irrespective of the degree of control over 2. Second, if firm 1 also obtains some degree of control over firm 2, then firm 1 will make firm 2 behave less aggressively, which increases the market profits of firm 1.[7] This framework has been extended to consider collusion (Gilo et al. 2006); mergers (Foros et al. 2011); asymmetric costs (Shelegia and Spiegel 2012); R&D investments (López and Vives 2019; Bayona and López 2018; Papadopoulos et al. 2019); and managerial incentives (Anton et al. 2020). 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.

The effects of common ownership have also been documented in empirical work (Azar et al. 2016; O'Brien and Waehrer 2017; Azar et al. 2018; Nain and Wang 2018; Park and Seo 2019; Banal-Estañol et al. 2020). In particular, Bindal (2019) using data of mergers and acquisitions of publicly listed firms finds that an increase in common ownership significantly raises a firm's gross margin for firms with similar products, which is consistent with the results of our paper.

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 two typical common ownership structures. In Section 5, we add a previous stage to the game pre-

[7] Barone et al. (2020) show that a regulatory reform that prohibited common directors among Italian banks decreased rates charged to customers by 10-30 basic points.

sented 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 i and k index firms, and j index investors. Each firm is owned by investors with financial stakes with potentially different degree of control. Denote α_{ji} as the share of firm i owned by investor j. We write α_i $(= \alpha_{ii})$ as the shares of firm i retained by investor $j = i$ and not sold to other investors. We also allow for minority (non-controlling shareholders) and introduce z_i as the fraction of firm i's profit owned by them. Then $z_i = 1 - \sum_j^I \alpha_{ji}$ with $0 \leq z_i < 1$, and $\alpha_i = 1 - z_i - \sum_{j \neq i}^I \alpha_{ji}$.[8]

Following Salop and O'Brien (2000) we allow for different corporate control structures by introducing the parameter ζ_{ji}, which captures the extent of investor j's control over firm i. Thus, $\sum_j^I \zeta_{ji} = 1$ for any i. With proportional control, managers maximize their shareholders' portfolios taking control interests in proportion to financial interests: $\zeta_{ji} = \alpha_{ji}$ for all j, i; with silent financial interests, an investor of each firm i (which we refer to as investor $j = i$) has total control over it, thus: $\zeta_{ii} = 1$ and $\zeta_{ji} = 0$ for $j \neq i$.

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 i sets a price, p_i. 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 i, its operating profit is $\pi_i = (p - c)q$. The total (portfolio) profit of investor j is $\pi^j = \sum_k^N \alpha_{jk}\pi_k$, where π_k is firm k's profit. Given the existing COs, the manager of firm i maximizes a weighted average of the investors' portfolio profits:

$$\sum_j^I \zeta_{ji}\pi^j = \left(\sum_j^I \zeta_{ji}\alpha_{ji}\right)\pi_i + \sum_j^I \zeta_{ji} \sum_{k \neq i}^N \alpha_{jk}\pi_k.$$

[8] 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).

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

$$\Pi_i = \pi_i + \sum\nolimits_{k \neq i}^{N} \lambda_{ik} \pi_k, \text{ where } \lambda_{ik} \equiv \frac{\sum_j^I \zeta_{ji} \alpha_{jk}}{\sum_j^I \zeta_{ji} \alpha_{ji}}. \tag{1}$$

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

3 Price Competition

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

$$\Pi_i = (p-c)\frac{Q(p)}{L} + \sum_{k \in \Omega \setminus \{i\}}^{N} \lambda_{ik}(p-c)\frac{Q(p)}{L} \text{ if } p_i = p, \text{ and}$$

$$\Pi_i = \sum_{k \in \Omega \setminus \{i\}}^{N} \lambda_{ik}(p-c)\frac{Q(p)}{L} \quad \text{if} \quad p_i > p.$$

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

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

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.[9]

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

By simplifying we obtain

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

Hence, the weight that firm i's manager puts on firm i 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 the other firms. Hence, the following condition needs to be satisfied

$$\sum_{k\neq i}^{N} \lambda_{ik}(p-c)\frac{Q(p)}{N-1} \leq (p-c)\frac{Q(p)}{N} + \sum_{k\neq i}^{N} \lambda_{ik}(p-c)\frac{Q(p)}{N}.$$

This condition states that the internalized profit from setting a price higher than the candidate equilibrium price (which consists of i'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

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

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

Note that λ_{ik} increases with the control over firm i exercised by investors with high stakes in firm k (high ζ_{ji} along with high α_{jk} increases the numerator $\sum_{j=1}^{I} \zeta_{ji}\alpha_{jk}$), and as the ownership concentration and control of firm i diminishes (i.e., as the denominator $\sum_{j=1}^{I} \zeta_{ji}\alpha_{ji}$ 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 $i = 1, 2, ..., N$:*

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

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. Notice that (4) encompasses general common ownership and control structures, including the particular cases of silent financial interests and proportional control.

For a given corporate control structure, Proposition 1 states that the higher the number of other firms, the higher the 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 alongside 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. The way to achieve that is for investors to exchange a higher fraction of firms' shares, so that each manager internalizes less of her own firm's profits and more of other firms' profits.

When the ownership concentration of firm k measured by the sum $\sum_{j=1}^{I} \zeta_{ji} \alpha_{jk}$ (i.e., the numerator of λ_{ik}) is equal to the ownership concentration and control of firm i measured by the sum $\sum_{j=1}^{I} \zeta_{ji} \alpha_{ji}$ (i.e., the denominator of λ_{ik}) for all $i \neq k$, Proposition 1 holds for all i. Then, it follows the next corollary which is a special case of Proposition 1.

COROLLARY 1 *The CO structures that satisfy $\sum_{j=1}^{I} \zeta_{ji} \alpha_{jk} = \sum_{j=1}^{I} \zeta_{ji} \alpha_{ji}$ for all $i \neq k$ 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.[10]

4 Applications to Typical Common Ownership Structures

We now apply Proposition 1 to the two aforementioned types of corporate control structures. For the illustrative examples, set $N = I = 3$ and define

$$A = \begin{pmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \end{pmatrix} \text{ and } \Lambda = \begin{pmatrix} \lambda_{11} & \lambda_{12} & \lambda_{13} \\ \lambda_{21} & \lambda_{22} & \lambda_{23} \\ \lambda_{31} & \lambda_{32} & \lambda_{33} \end{pmatrix}.$$

Furthermore, let $\bar{z}_i \equiv (1 - z_i)$ be the fraction of shares of each firm i owned by non-minority investors, and to simplify the exposition assume that $z_i = z > 0$ for all i. We also introduce the term

$$\beta_i = \textstyle\sum_{j \neq i}^{I} \alpha_{ij}.$$

With silent financial interests, β_i is the sum of the stakes that the controlling investor of firm i has on the rest of firms, whereas in the case of proportional control β_i is the sum of the stakes that the investor $j = i$ of firm i has on the rest of firms.

Silent Financial Interests

For silent financial interests, Proposition 1 reduces to $\alpha_i = \frac{\beta_i}{(N-1)}$. Any price between c and the monopoly price can be an equilibrium provided that the share α_i of i's controlling shareholder in firm i is equal to the average stake that she has in other firms, $\beta_i/(N-1)$. When this condition holds, the shareholder neither wishes to undercut all the rivals, in which case she would get a share α_i 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

[10] As an example, consider the case of silent financial interests. In this case $\zeta_{ii} = 1$ and $\zeta_{ji} = 0$ for $j \neq i$. The condition of Corollary 1 becomes $\alpha_{ik} = \alpha_i$ for all $i \neq k$. This means that, if each investor holds the same share of every firm, then no manager has an incentive to deviate.

she has the average stake of $\beta_i/(N-1)$.

Notice that for Proposition 1 to hold, for a given α_i, if the number of firms in the industry increases we need β_i to increase – the controlling investor of firm i needs to own more stakes of the other firms. For a given β_i, if N increases we need α_i to decrease – the controlling investor of firm i needs to sell more stakes of her own firm.

An example which illustrates an asymmetric CO configuration that admits price equilibria with positive (even monopoly) profit with silent financial interests is:

$$A = \begin{pmatrix} \overline{z}/3 & 2\overline{z}/3 & 0 \\ 0 & \overline{z}/3 & 2\overline{z}/3 \\ 2\overline{z}/3 & 0 & \overline{z}/3 \end{pmatrix} \tag{5}$$

with $\zeta_{ij} = 1$ for all $i = j$ and $\zeta_{ij} = 0$ for all $i \neq j$. Then

$$\Lambda = \begin{pmatrix} 1 & 2 & 0 \\ 0 & 1 & 2 \\ 2 & 0 & 1 \end{pmatrix}.$$

In this example the conditions of Proposition 1 are satisfied but not those of Corollary 1. This structure is suited to describe the case of a founder and the presence of venture capitalists that invest in the firm without exerting control on it.[11] Note that the existence of minority shareholders, $z_i > 0$, 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 i weighs firm i's profits less, and therefore investors need to own a lower proportion of the other firms to keep the common price.

We turn now to analyze the role of ownership concentration in the existence of the equilibrium with positive profits. We first introduce some notation and define $\varphi_i = 1 - \alpha_i$ as the share of firm i owned by investors $j \neq i$, and $\rho_{-i} = \sum_{k \neq i}^{N} \varphi_k - \beta_i$ as all the common ownership arrangements not involving firm i. To study the role of ρ_{-i} in conjunction

[11] With symmetric silent financial interests the configuration $\alpha_{ji} = \bar{z}/3$ for all j, i with $\lambda_{ik} = 1$ for all i, 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.

with φ_i and β_i, we first sum up (4) across all firms, which gives us a necessary condition for Proposition 1 to be fulfilled when $N \geq 3$: $(N-1) + \sum_i^N z_i/N = \sum_i^N \varphi_i$, the number of rivals plus the average firms' profit owned by minority (non-controlling) shareholders must equal the sum of participations in each firm's profit.[12] We thus have the following system of equations:

$$(N-1) + \textstyle\sum_i^N z_i/N = \sum_i^N \varphi_i \tag{6}$$

and, rewriting condition (4),

$$\textstyle\sum_i^N \varphi_i = \varphi_i + \beta_i + \bar{\rho}_{-i}, \tag{7}$$

where $\bar{\rho}_{-i} \equiv \rho_{-i} - \sum_i^N z_i/N$. The solution to this system of equations is given by: $\varphi_i = \frac{\bar{\rho}_{-i}}{N-2}$ and $\beta_i = \frac{N-1}{N-2}(N-2-\bar{\rho}_{-i})$. Notice that φ_i is increasing in ρ_{-i} and decreasing in N, while β_i decreases with ρ_{-i} and increases with N.

The interpretation is as follows. Consider firm i. The more the controlling investors of the other firms own stakes of each other, the more dispersed the ownership structure is, and the less the managers of other firms are interested in the profit of their own firm. In order to maintain the incentive not to deviate, firm i must mirror this more dispersed ownership structure. Therefore, a more dispersed ownership structure pushes the controlling investor of firm i to own less stakes of firm i (thus, φ_i increases with ρ_{-i}). Having less stakes in one's own firm increases the incentive to raise the price (and exit the market) in order to enjoy positive profits through the participations in other firms. In turn, firm i refrains from raising the price when the controlling investor of firm i reduces the partial ownership stakes in the other firms (thus, β_i decreases with ρ_{-i}).

[12] With $N = 2$ firms i and k, (4) reduces to $(1 - \varphi_i) = \beta_i$ and $\rho_{-i} = z_k$.

Proportional Control

In the case of proportional control we have that $\zeta_{ji} = \alpha_{ji}$ for all j, i, therefore for I investors, the parameter λ_{ik} is given by

$$\lambda_{ik} = \frac{(1 - z_i - \sum_{j \neq i}^{I} \alpha_{ji})\alpha_{ik} + \alpha_{ki}(1 - z_k - \sum_{j \neq k}^{I} \alpha_{jk}) + \sum_{j \neq i,k}^{I} \alpha_{ji}\alpha_{jk}}{(1 - z_i - \sum_{j \neq i}^{I} \alpha_{ji})^2 + \sum_{j \neq i}^{I} \alpha_{ji}^2} \tag{8}$$

As above, let $N = I = 3$. An example that illustrates a symmetric CO configuration that admits price equilibria with positive (even monopoly) profit with proportional control is $\alpha_{ji} = \overline{z}/3$, which implies that $\zeta_{ji} = \overline{z}/3$ for all i, j. It follows that

$$\lambda_{ik} = \frac{3\left(\overline{z}/3\right)^2}{3\left(\overline{z}/3\right)^2} = 1$$

for all $i \neq k$. Note that $\sum_{j=1}^{I} \zeta_{ji}\alpha_{jk} = \sum_{j=1}^{I} \zeta_{ji}\alpha_{ji}$, thus Corollary 1, and therefore Proposition 1, hold. As in the case of silent financial interests and because of the same reason, the existence of minority shareholders facilitates the monopoly outcome: investors need to own a lower proportion of rivals' shares to sustain the monopoly price.

Although examining analytically asymmetric configurations with proportional control is in general non-tractable, we can resort to numerical simulations to illustrate the role of ownership concentration. Let $\overline{z} = 0.3$ and $\alpha_{23} = \alpha_{32} = 0.06$, then $\alpha_{12} = \alpha_{13} = 0.18$ and $\alpha_{21} = \alpha_{31} = 0.06$, yielding

$$A = \begin{pmatrix} 0.58 & 0.18 & 0.18 \\ 0.06 & 0.46 & 0.06 \\ 0.06 & 0.06 & 0.46 \end{pmatrix},$$

satisfy (4) with $\lambda_{ik} = 1$ for all $i \neq k$.

(ii) Let $\overline{z} = 0.3$ but higher α_{23}, α_{32} with $\alpha_{23} = \alpha_{32} = 0.08$, then $\alpha_{12} = \alpha_{13} = 0.14$ and

$\alpha_{21} = \alpha_{31} = 0.08$, yielding

$$A = \begin{pmatrix} 0.54 & 0.14 & 0.14 \\ 0.08 & 0.48 & 0.08 \\ 0.08 & 0.08 & 0.48 \end{pmatrix},$$

satisfy (4) with $\lambda_{ik} = 1$ for all $i \neq k$.

These results for the two asymmetric cases with proportional control are in line with those obtained in case of silent financial interests: an increase in ρ_{-1} driven by α_{23} and α_{32}, increases α_{21} and α_{31} (and therefore φ_1), and decreases α_{12} and α_{13} (and therefore β_1).

5 Incentives to Form CO Structures

In this section we address the issue of whether an ownership structure is an equilibrium. 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.[13]

We introduce a previous stage 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 structures that support positive profits. There are however many possible distributions of the total industry profit among investors depending on the ownership structure.

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

[13] 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.

among investors. The two-stage game is solved by backward induction, thus we have to determine at what equilibrium price firms will coordinate on in the pricing stage. As pointed out in Harsanyi (1964), Harsanyi and Selten (1988) and Fudenberg and Tirole (1983), it is reasonable to expect that rational players will select the payoff dominant equilibrium.[14] 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 payoff dominant 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.[15] 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 (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*

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

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 next show that the ownership structure given by (4) satisfies these two conditions.[16]

[14] An equilibrium is strictly payoff dominant if all players receive higher payoffs in this equilibrium than in any other equilibrium.

[15] 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.

[16] There are other stability concepts such as the pairwise Nash equilibrium and strong stability con-

We first reformulate the conditions in terms of an ownership structure formation game. To that end, we let A_i be the vector of stakes of firm i owned by all investors $j \neq i$: $A_i = [\alpha_{i1,}\alpha_{i2}, .., \alpha_{i-1}, \alpha_{i+1}, .., \alpha_{iN}] \in [0,1]^{N-1}$, and $A = A_1 \times \cdots \times A_N$ be the Cartesian product of A_i, 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 $a_i \in A_i$.

Consider the owners x and y, and define $\pi^j(a+\alpha)$ and $\pi^j(a-\alpha)$ as the payoff of investor j when the stake $\alpha > 0$ is traded and removed respectively, with $\alpha \in \{\alpha_{xy}, \alpha_{yx}\}$. 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

$$\pi^j = \left[(1 - z_j - \textstyle\sum_{k\neq j}^N \alpha_{kj}) + \textstyle\sum_{k\neq j}^N \alpha_{jk}\right] \pi_M/N, \tag{9}$$

where π_M is the monopoly profit, and therefore the sum $\pi^x + \pi^y$ is independent of α. The reason is that each firm makes the symmetric payoff π_M/N at 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. Therefore, for given mass of minority shareholders, $z_1, ...z_N$, we have the following proposition.

cepts. 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.

PROPOSITION 2 *For any given corporate control structure, any configuration a^* that satisfies (4) is pairwise stable.*

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.[17] As in the network formation game, we consider the payoff dominant equilibrium in the second stage, thus we assume that firms coordinate on the equilibrium with monopoly price when Proposition 1 holds.

Suppose that prior to the bargaining, each investor j is endowed with an exogenous bargaining power σ_j, with $\Sigma_j \sigma_j = 1$.[18] Then each j obtains $\varphi^j \equiv \sigma_j \pi_M[1 - \sum_k^N z_k/N]$, 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 i's minority shareholders receive $z_i \pi_M/N$.

At the payoff dominant equilibrium the total (portfolio) profit of investor j is $\pi^j = \sum_k^N \alpha_{jk}\pi_M/N$. Then, it must hold that $\sum_k^N \alpha_{jk}\pi_M/N = \sigma_j \pi_M[1 - \sum_k^N z_k/N]$ for each investor j, or equivalently,

$$\frac{\sum_k^N \alpha_{jk}}{N} = \sigma_j[1 - \textstyle\sum_k^N z_k/N]. \tag{10}$$

Also, the condition in Proposition 1 must hold for each firm i. Thus, the ownership structure satisfying (4) and (10) yields φ^j for each investor j. Next, we show the ownership and bargaining power configurations that satisfy these conditions in the two typical common ownership structures analyzed.

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

[18] 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).

Silent Financial Interests

We have that $\lambda_{ik} = \alpha_{ik}/\alpha_i$, thus (4) can be written as

$$\sum\nolimits_{k \neq j}^{N} \alpha_{jk} = \alpha_j (N-1). \tag{11}$$

The numerator of left-hand side of (10) is the sum of two terms: $\alpha_j + \sum_{k \neq j}^{N} \alpha_{jk}$, then by replacing the second term with (11) we can rewrite (10) as

$$\alpha_j = \sigma_j \left(1 - \sum\nolimits_k^N z_k/N\right). \tag{12}$$

The ownership structure satisfying (11) and (12) shares the monopoly profit such that each controlling investor j obtains φ^j.

Applying it to the example illustrated in Section 4 for silent financial interests, we find that the distribution $\sigma_i = 1/3$ for $i = 1, 2, 3$ yields matrix (5) with $\zeta_{ij} = 1$ for all $i = j$, and $\zeta_{ij} = 0$ such that $i \neq j$.

Proportional Control

For simplicity, we consider the case of proportional control with symmetric stakes. Recall that $\lambda_{ik} = N\alpha^2/N\alpha^2 = 1$. Thus, (4) is satisfied. Since $\sum_k^N \alpha_{jk} = N\alpha$, proportional control with symmetric stakes yield φ^j for each investor j if the distribution of bargaining power is such that

$$\alpha = \sigma_j \left(1 - \sum\nolimits_k^N z_k/N\right).$$

Applying it to the symmetric example illustrated in Section 4 for proportional control, we find that $\sigma_i = 1/3$ for $i = 1, 2, 3$ yielding $\alpha_{ji} = \bar{z}/3$ and $\zeta_{ji} = \bar{z}/3$ for all i, j.

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 or a bargaining problem among investors.

Our results apply to various corporate control structures, including (as special cases) silent financial interests and proportional control, and any number of firms. We find that the higher the number of firms, the higher the stakes of other firms that investors must own in order to deter firms' managers from deviating in the price competition stage. For a given corporate control structure, a higher number of firms increases the incentives to deviate: therefore, in order to make firms' managers not to do so, investors must own a higher fraction of other firms' shares, so that each manager internalizes more of other firms' profits. This can be achieved directly or indirectly, e.g. investors purchasing shares of a company which buys shares of other firms' shares. 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.

Our theoretical results are consistent with the empirical results of Bindal (2019) that shows that COs among firms selling similar products significantly increase prices. Since firms can achieve the monopoly outcome even in an environment of strong competition, such as in Bertrand with homogeneous products, competition authorities should be highly suspicious of the existence of financial links in an industry.[19] 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.

References

[1] Anton, M., Ederer, F., Gine, G., and Schmalz, M. C. (2020). Common Ownership, Competition, and Top Management Incentives. European Corporate Governance

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

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., Sahil, R., and Schmalz, M. C. (2016). Ultimate ownership and bank competition. Working paper.

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

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

[6] Backus, M., Conlon, C., and Sinkinson, M. (2020). Common ownership in America: 1980-2017. American Economic Journal: Microeconomics.

[7] Banal-Estañol A., Seldeslachts J., and Vives X. (2020), Financial Markets, Common Ownership and Product Market Outcomes, working paper.

[8] Barone, G., Schivardi, F., and Sette, E. (2020). Interlocking Directorates and Competition in Banking. Working paper.

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

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

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

[12] Bindal, S., (2019). When Does Common Ownership Matter?. Working paper

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

[14] Bloch, F., 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] Clapp, J. (2019). The rise of financial investment and common ownership in global agrifood firms. Review of International Political Economy, 26(4), 604-629.

[17] Eldar, O., Grennan, J., and Waldock, K. (2020). Common Ownership and Startup Growth. Duke Law School Public Law & Legal Theory Series No. 2019-42, Georgetown McDonough School of Business Research Paper No. 3406205.

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

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

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

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

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

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

[24] 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.

[25] Harsanyi J. C., and Selten R., (1988). A General Theory of Equilibrium Selection in Games, MIT Press.

[26] 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.

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

[28] Jackson, M. (2008). Social and Economic Networks. Princeton; Oxford: Princeton University Press.

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

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

[31] Muthoo, A. (1999). Bargaining Theory with Applications. Cambridge University Press.

[32] 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.

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

[34] 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.

[35] 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).

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

[37] 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.

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

[39] 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.

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

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

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