When do common owners facilitate collusion? The role of agency frictions and repeated interaction*

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Abstract

We study the incentives to sustain collusion in a simple dynamic model where - due to agency frictions - firm managers derive a short-term private benefit from deviating from collusion. For industries "naturally" disposed towards collusion, we find that collusion is more difficult to sustain when a single investor owns all firms in an industry compared to a situation with separate investors. This counterintuitive result obtains because a common owner, unlike separate owners, will restore collusion after a deviation. Therefore managers' short-term gain from deviation might outweigh its long-term costs under a common owner. We find support for our main prediction in the data: common ownership seems to increase industry profitability, but not in industries more "naturally" disposed towards collusion.

Keywords: ownership, industry competition, repeated interaction, agency frictions
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1 Introduction

A small number of large institutional investors (BlackRock, Vanguard, State Street, and others) have acquired significant stakes in competing firms over the last three decades. While the increase in common ownership since the 1980s is well documented, the consequences of this change are strongly debated. Some authors argue that higher levels of common ownership lead to reduced product market competition and provide empirical support in this direction (Azar et al. (2018), He and Huang (2017), Kang et al. (2018), Antón et al. (2020)), whereas others find mixed or no empirical evidence in favor of the so-called common ownership hypothesis (Koch et al. (2021),Lewellen and Lowry (2021)).[1]

In most models of common ownership, higher levels of common ownership unambiguously lead to lower product market competition. These models are typically static and common owners are thought to have sufficient influence over firm managers to implement collusive behavior.[2] In this paper, we study the impact of common ownership on competition in a simple *dynamic* model where, additionally, we introduce an agency friction between firm owners and managers.

Our main finding is that, in our model setting, common owners' incentive to promote anti-competitive behavior undermines firms' ability to collude. The argument is based on the well-established logic of repeated games. An effective way of sustaining collusion under separate owners is through a threat of reverting to non-cooperative behavior after defections (i.e., a price war). However, a common owner cannot credibly commit to letting the firms compete aggressively. After collusion has failed, the common owner prefers to "let bygones be bygone" and steer the firms towards a new collusive agreement. More broadly, the common owner shuns any action that fails to maximize joint profits - for example, threatening to fire the manager after defection is not credible if replacing the manager is costly for the owner.

It has long been recognized that renegotiation incentives undermine collusion in repeated games.[3] The common owner's capacity to coordinate the managers of the rival firms magnifies this renegotiation problem. In the second part of the paper, we test the model's main predictions in the data. Our empirical results support the main mechanism of the model, potentially rationalizing the mixed empirical evidence of common ownership on product market competition.

In our model, two rival firms interact repeatedly in the same market. This leads to a standard repeated prisoner's dilemma, where joint profits are highest when both firms collude, lowest when both firms compete fiercely, and a firm gets high profits by deviating from collusion. Importantly,

[1] Koch et al. (2021), for example, write that "[...] if one argues that common ownership should be discouraged among a specific set of industries, there is a roughly equally sized set for which we should apparently encourage common ownership."

[2] See, for example, Hansen and Lott (1996), O'brien and Salop (1999), Gordon (2003), Azar (2012), and López and Vives (2019), among others.

[3] For example, Farrell and Maskin (1989) summarize the ex-post incentives in repeated interactions as follows: "Why should we submit to this bleak prospect? Why not "let bygones be bygone" and return to the original equilibrium path, which gives higher payoffs?"

within each firm, the interests of the management can differ from the interests of the firm owners because managers can divert a fraction of the firm's cash flow for her benefit. The manager's "diversion opportunities" represent the many ways management can expropriate the shareholders (Gompers et al. (2003)). Firm owners can offer managers a collusive or non-collusive contract. The collusive contract pays the manager to maximize joint firm profits, whereas the non-collusive contract pays the manager to maximize only her firm's profit.

Managers and firm owners agree that the optimal course of action is to collude. Ex-post, however, managers may want to deviate from the collusive agreement and earn high short-term profits because deviation allows managers to divert more money for themselves. The possibility of a higher cash-flow diversion by deviating from the collusive agreement makes the collusive contract more expensive for the firm owner because he has to promise a "collusion bonus" to the managers amounting to the foregone benefit of defection.[4]

We then study differences between separate owners and a common owner. Separate owners will not pay such collusion bonuses since they want the managers to maximize firm rather than industry profit. On the other hand, a common owner chooses to pay collusion bonuses if the monetary gain from anti-competitive behavior exceeds the sum of collusion bonuses. Thus, the separation of ownership and control plays a central part in the firms' colluding capacity. If the objectives of the managers and the owner are sufficiently well aligned, a common owner would always increase collusion.

It is well-known that repetition makes collusion easier by using trigger strategies (see Friedman (1971) and the subsequent literature on "folk theorems"). Each manager is initially put on a collusive contract and thus induced to cooperate. If ever any firm defects, all managers are induced to compete after that. In our setup, the firms are run by managers whose compensation schemes are selected by the owners. The owners must be motivated to offer contracts that induce the managers to play trigger strategies (i.e., trigger contracts). These contracts, when credible, contain a threat: each manager recognizes that a defection ushers in a period of aggressive competition and low profits (and thus low managerial compensation).

As long as the players are sufficiently patient, trigger strategies constitute (a subgame perfect) equilibrium of the repeated game under separate ownership. Specifically, if a firm ever defects, the game enters the punishment phase where each separate owner best responds by putting the manager of his firm on the non-collusive contract - expecting the other firm owners to do the same. The punishment phase is self-enforcing: each owner best responds by putting the manager on the non-collusive contract, and, given his compensation package, each manager best responds by behaving uncooperatively. Finally, each manager recognizes that a short-term gain from defection is credibly

[4]More broadly, the managers would earn "collusion rents" in industries where anti-competitive practices increase their power relative to the owners. Such situations arise naturally if non-colluding managers benefit (in monetary or non-pecuniary terms) from increased industry collusion. In the terminology of Segal (1999), traders (i.e., colluding managers) impose a positive externality on non-traders (i.e., defecting managers), generating free-rider incentives.

penalized by a long-term bleak prospect of aggressive competition.

A common owner in the same situation as separate owners (i.e., a firm has defected) faces different incentives. Unlike the separate owners, the common owner selects the compensation packages of all managers and is therefore in a position to affect their behavior simultaneously. He can put each manager on a non-collusive and let the punishment phase unfold as initially planned.

However, inducing aggressive competition (i.e., a price war) hurts the managers and the common owner since joint profits will be lower. The common owner prefers to abandon the punishment and restart the collusive agreement. Thus, common ownership implies that the collusive agreement based on trigger strategies is not credible. It is important to stress that threats to fire the managers after a defection are also plagued by a lack of credibility - as long as replacing the manager is costly for the common owner due to search cost or because the incumbent management is more efficient in running the firm.[5]

The model delivers novel predictions. Specifically, we use two numbers to characterize each industry: θ and δ. First, θ denotes the divergence of objectives between the common owner and the managers. It measures managers' incentive to defect from the collusive agreement due to financial frictions or non-pecuniary incentives. Second, δ denotes an industry's "natural" propensity for tacit collusion (i.e., through trigger strategies). Tacit collusion is easier in industries with fewer firms, less uncertain demand functions, and more symmetric cost structures (Ivaldi et al. (2003)). We refer to those as high-δ industries. The model predicts that common ownership tends to decrease collusion in industries with a high natural predisposition towards collusion (high δ industries). At the same time, common ownership tends to increase collusion in industries with low agency costs (low θ industries).

We use industry-level measures of common ownership by Koch et al. (2021) to test the main predictions of our model. Our classification of industries into collusion-prone, i.e., industries with a high δ, and other industries is taken from Grout and Sonderegger (2005), who compute collusion probabilities based on industry variables, such as concentration indices, entry barriers, and demand characteristics. To measure the severity of the agency problem between owners and managers, denoted θ in our model, we compute industry averages of the Gompers et al. (2003) index. Consistent with our model, we find that increases in common ownership are associated with lower industry profitability in high δ industries. We also find increases in industry profitability when the agency problem in an industry is small, which is consistent with our theory. Thus, the model can account for some of the heterogeneous impacts of common ownership found in the literature.

We contribute to the theoretical literature about the effects of common ownership on product

[5]This mechanism is related to the Coasian durable good monopolist (Coase (1972)). A durable good monopolist sets the profit-maximizing price and sells to all customers whose willingness to pay exceeds that price. Subsequently, the monopolist will be tempted to lower the price to absorb the residual demand. Anticipating future price cuts, the customers abstain from buying at the initial high price. Stated differently, the monopolist is in a price war with his future self. If the customers are patient enough (and subject to technical conditions, see McAfee and Wiseman (2008)), the equilibrium price immediately falls to marginal cost - an outcome known as the Coasian conjecture.

market competition. The main insights from our model are related to various strands of the existing literature: common ownership in our model has similar effects on product market competition as horizontal mergers in Reynolds and Snapp (1986) and Farrell and Shapiro (1990), cross-ownership among rival firms in Malueg (1992) and Gilo et al. (2006), and increased concentration in Davidson and Deneckere (1984).

We differ from Davidson and Deneckere (1984) and Malueg (1992) in several critical ways. First, there is a separation of ownership and control in our model but not in theirs. Understanding the effects of common ownership is incomplete without accounting for managerial incentives. Second, the parties are not restricted to specific contractual arrangements or capital structures (i.e., equity contracts in Malueg (1992)). Third, the parties in our model can renegotiate at any point. The opportunity to renegotiate differentiates our work from previous papers on common ownership effects. Finally, unlike Davidson and Deneckere (1984) and Malueg (1992), the implications of our model do not rely on specific demand conditions and types of competition.

The paper is also related to the literature on financial compensation and product-market competition. In these models, the choice of managerial compensation commits the firm to follow specific product-market strategies.[6] The agency costs in our model imply that the managers earn collusion rents when their firms behave anti-competitively. In the baseline model, this stems from financial friction: the amount each manager can divert increases in his firm's profit. In an extension, we assume that the managers derive private benefits that increase their firm's profit and show that the main message carries through.[7]

We contribute to the empirical literature studying the effects of common ownership on product market competition by shedding light on the likely factors determining whether common investors increase or decrease competition in a specific industry. Koch et al. (2021) find mixed empirical evidence with increases in common ownership in some industries leading to lower mark-ups while increasing mark-ups in other industries. They also find no impact of increases in common ownership in collusion-prone industries which is consistent with our model, where collusion under common ownership is harder to sustain in these industries.[8] Most of the literature studying the effects of common ownerhship on product market competition provides one-shot models (for example Antón et al. (2020), Backus et al. (2019)) or no model at all. The main implication is then that common owners tend to facilitate collusion by either direct intervention or by giving appropriate incentives

[6]See Brander and Lewis (1986), Sklivas (1987), Maksimovic (1988), Bolton and Scharfstein (1990), Aggarwal and Samwick (1999), and Cestone and White (2003) among others.

[7]Several factors can lead to a positive link between firm profit and managerial non-pecuniary payoffs. First, the market rewards managers that out-compete their rivals and induce myopic behavior (see Stein (1988)). Second, a manager might prefer to increase short-term profits to consume more perquisites. Third, a manager with sufficient control might divert the firm's resources by, for example, convincing the board to grant him a greater bonus or green lighting his pet projects.

[8]Other explanations in the literature for the mixed empirical evidence include identification problems (Lewellen and Lowry, 2021), common investors might not want to promote collusion (Lewellen and Lewellen (2018)), and common investors might not pay attention and firm managers internalize this (Gilje et al., 2020).

to the managers to behave cooperatively. However, these papers do not focus on dynamic considerations, which is the central focus of our paper. We apply the theory of oligopolistic competition to common ownership.

Finally, our model also contributes to the literature studying the effects of common ownership on managerial compensation (Ha et al. (2020), Antón et al. (2020), Liang (2016)). In particular, high-powered managerial compensation (i.e., one based on firm rather than industry performance) does not necessarily imply that the firms are behaving competitively. Equilibrium in trigger strategies implies that a defection increases short-term profit but decreases long-term profits by an even greater amount. Thus, using low-powered incentives (i.e., managerial compensation based on industry performance) as an indicator of collusion might overestimate the anti-competitive effect of common owners. The reason is that collusion based on trigger strategies (i.e., high-powered incentives) is more likely to be implemented by common rather than separate owners.

2 An example

The following numerical example illustrates the main mechanism: two rival firms play a prisoner's dilemma. Each firm chooses whether to play cooperatively by choosing C or uncooperatively by choosing N. Cooperation is an action benefiting both firms: producing low quantities, setting high prices, sharing information, avoiding costly litigation, etc. The firm's profits are displayed in Table 1.

Payoffs	Cooperate (C)	Defect (N)
Cooperate (C)	20, 20	0, 30
Defect (N)	30, 0	15, 15

Table 1

Each firm has an owner and a manager. Each manager can divert a portion $\theta = \frac{4}{10}$ of the firm's profit for his consumption. The owners offer compensation contracts to the managers (assume that the owners make take-it-or-leave-it offers). Each manager chooses to cooperate C or to defect N, and profits are realized. Each manager then chooses whether or not to divert portion $\theta = \frac{4}{10}$ of his firm's profit. Finally, the remaining profits are allocated among each firm's owner and its manager according to their contract (which can stipulate that the manager gets zero after diversion).

Under separate ownership, there are four players: owner 1, owner 2, manager 1, and manager 2. Under common ownership, there are three players: the owner, manager 1, and manager 2. In this example, we show that collusion can be potentially maintained under separate ownership but not under common ownership. To better illustrate the roles of agency costs and time consistency, we begin by analyzing the one-shot game.

One-shot interaction. Each manager is induced to cooperate (i.e., to choose C) by the following contract: the manager is paid $r^C = \frac{4}{10}30 = 12$ for choosing C and not diverting and zero otherwise (i.e., for choosing N or diverting). Putting both managers on this collusive scheme ensures that they cooperate. Note that by cooperating, each firm earns 20, and hence, the manager can divert $\frac{4}{10}20 = 8$. However, each manager is paid $r^C = 12 > 8$ to cooperate. Paying the manager less than 12 is not incentive-compatible: the manager would choose N and divert $\frac{4}{10}30 = 12$. In other words, sustaining cooperation is costly since each manager earns strategic rent.

On the other hand, each manager can be induced not to cooperate (i.e., to choose N) by the following contract: the manager is paid $r^N = \frac{4}{10}15 = 6$ for choosing N and not diverting and zero otherwise (i.e., for choosing C or diverting). Putting both managers on this no-collusive scheme ensures that they do not cooperate. Note that the managers do not earn strategic rents, i.e., each is paid the minimum amount necessary to prevent cash flow diversion.

The collusive contract is equivalent to paying each manager a proportion $\frac{3}{10}$ of total firm profits (thus, if the firms cooperate, each manager gets $\frac{3}{10}(20 + 20) = 12$). The no-collusive contract is equivalent to paying each manager a proportion $\frac{4}{10}$ of his firm's profit. Note that the managers do not have to be instructed to explicitly collude or write contracts that specify certain behavior (i.e., the owners need not concern themselves with the day-to-day operation of the firm).

Suppose the firms have separate owners and let both managers be given the collusive contract r^C. Each owner's payoff is $20 - r^C = 8$, and each manager's payoff is $r^C = 12$. Such an outcome, however, is not consistent with equilibrium. The owner of firm $i = 1, 2$ and its manager can renegotiate: the manager gets $\tilde{r}^N = 12 + \epsilon$ for choosing N and not diverting and zero otherwise (i.e., for choosing C or diverting). For $\epsilon \in (0, 10)$, the manager accepts and chooses N giving a payoff of $30 - 12 - \epsilon > 8$ for the owner and $12 + \epsilon > 12$ for the manager implying that they are both better off. Thus, collusion unravels as long as renegotiation is secret (secrecy prevents the other firm from reacting).

Next, suppose the two firms have the same owner. The common owner's payoff from putting both managers on the collusive contract is $2(20 - 12) = 16$ (i.e., $20 - 12 = 8$ from each firm), whereas his payoff from putting them on the no-collusive contract is $2(15 - 6) = 18$. Thus, the common owner maximizes his overall payoff by inducing the managers to behave non-cooperatively. The reason is that the total collusion bonus that must be given to the managers $2(r^C - r^N) = 12$ exceeds the total collusion gain of 10. That is, collusion is not self-financing.[9]

[9] We assume that each manager only observes his contractual offer (the common owner enters into private bilateral contracts with the managers). We must thus specify the managers' belief after observing an out-of-equilibrium offer. We assume that after observing an out-of-equilibrium offer inducing more active cooperation, each manager beliefs that the other managers have also received offers inducing more active cooperation. Such beliefs are consistent with the common owner's eagerness to implement collusion.

Repeated interaction. Now suppose the game is repeated and consider the following profile of trigger strategies: both firms start by cooperating. If ever one firm defects, then both firms do not cooperate anymore. The managers are induced to follow trigger strategies as follows. Each manager is paid r_T^C for choosing C and not diverting and zero otherwise (i.e., for choosing N or diverting). If ever one firm defects, both managers are thereafter paid $r^N = 6$ for choosing N and not diverting and zero otherwise (i.e., for choosing C or diverting). Suppose the discount factor $\delta \in (0,1)$ is sufficiently close to one, say $\delta = \frac{8}{10}$. Then setting $r_T^C = \frac{4}{10}20 = 8$ implies that each manager cooperates: he gets an overall payoff of $8/(1-\delta) = 40$ (recall $\delta = \frac{8}{10}$) on the collusive path whereas a defection implies an overall payoff of $\frac{4}{10}30 + \delta 6/(1-\delta) = 36$ (i.e., he deviates and diverts $\frac{6}{10}30$ and then gets $r^N = 6$ in each subsequent period).

Each separate owner prefers to stick to the collusive agreement rather than induce his firm's manager to defect. The maximum a separate owner can get by inducing defection is $\frac{6}{10}30 + \delta(15 - 6)/(1-\delta) = 54$, which is less than his payoff on the collusive path $(20-8)/(1-\delta) = 60$. Note that the (tacit) collusive agreement based on trigger strategies constitutes a subgame perfect Nash equilibrium and is, therefore, self-enforcing. After a defection, each separate owner puts his firm's manager on the no-collusive contract expecting the other to do the same.

A common owner, in contrast, cannot rely on trigger strategies to sustain self-enforcing cooperation. To see why suppose (to derive a contradiction) the common owner could use trigger strategies. The common owner's overall payoff on the collusive path is $2(20-8)/(1-\delta) = 120$, whereas his overall payoff from non-cooperation is $2(15-6)/(1-\delta) = 90$. After a defection, the common owner abandons the original profile of trigger contacts and restarts the collusive agreement. That is, each manager is paid 8 for choosing C and not diverting and zero otherwise (i.e., he lets "bygones be bygone"). The reason is that failing to renew collusion implies the common owner is not maximizing his continuation payoff.[10] As a result, each manager wants to defect since he gets $\frac{4}{10}8 + \delta 8/(1-\delta)$ on the collusive path and $\frac{4}{10}12 + \delta 8/(1-\delta)$ by defecting. Hence, a collusive agreement based on trigger strategies is not self-enforcing under common ownership. The common owner's inability to induce cutthroat competition after defection undermines collusion.

3 Baseline model

We illustrate the main ideas with a stylized model of oligopolistic competition. Many of the assumptions can be substantially relaxed without affecting the key message. The Appendix provides an alternative specification with similar implications.

[10] We assume that the managers always coordinate on the most preferred SPNE from the perspective of the common owner - a standard assumption in the literature studying one principle (the owner) dealing with many agents (the managers), see Segal (1999). Thus, if a given contract profile induces the managers to cooperate in period t, this same contract profile induces the managers to cooperate in any future period. This assumption is not critical and is made to simplify the exposition. The central message of the model holds as long as the common owner is more likely to restore collusion than separate owners.

3.1 The environment

Two symmetric rival firms play a Prisoner's dilemma. The payoff matrix is given in Table 2 (where $\tilde{\pi}^N > \pi^C > \pi^N \geq 0$).

Payoffs	Cooperate (C)	Defect (N)
Cooperate (C)	π^C, π^C	$\tilde{\pi}^C$, $\tilde{\pi}^N$
Defect (N)	$\tilde{\pi}^N$, $\tilde{\pi}^C$	π^N, π^N

Table 2

Managers and owners. There is a separation of ownership and control: the owner of each firm hires a manager to operate it. Under separate ownership, there are four players: manager 1, manager 2, owner 1, and owner 2. Under common ownership, there are three players: manager 1, manager 2, and the owner of both firms. Instead of assuming a single individual owning both firms, one can equivalently assume two (or more) common owners with equal stakes in each firm. The ownership structure is irrelevant if the investors form a coalition to maximize their joint profit. We assume that such coalitions are not feasible.

Agency costs. Each manager can divert portion $\theta \in (0, 1)$ of the firm's cash flows (i.e., if the firm gets π^C the manager can divert $\theta\pi^C$). One can also think of such diversion as the manager consuming perks or investing in pet projects (The appendix examines a version of the model with non-pecuniary payoffs.) The sequence of events within a stage is presented in Figure **??**. First, each manager chooses whether to behave cooperatively or uncooperatively, and cash flows realize. Each manager then chooses whether or not to divert a portion θ of his firm's cash flows. Any cash flows not diverted are allocated between the owners and managers (see below for the managerial contracts). The managers' ability to divert creates friction between management and ownership, affecting the firms' ability to sustain collusion. We assume that diversion is observed only by the firm's owner and manager but not by its rivals - assuming otherwise does not affect our results.

Contracts. The owner and manager of each firm write a contract specifying the manager's compensation. The only contractual restriction we impose is that the manager's payment must be greater than or equal to zero (i.e., limited liability). For example, the manager can (i) be given a fixed wage, (ii) retain a share of the equity, (iii) issue debt, or (iv) be given a specific incentive scheme (i.e., a bonus for meeting certain performance targets) and so on. Also, the manager's compensation package can depend on the cash flow generated by his competitor. That is, the managers can be induced to behave as if they partially own their rival firm. Note that there is a one-to-one mapping between the profile of actions and the profile of cash flows. Thus, a managerial contract based on

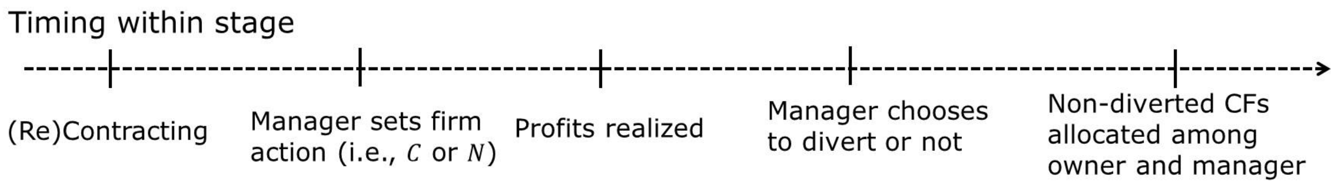


Figure 1: Timing of events within a stage.

outcomes (i.e., cash flows) can always be specified in terms of actions (cooperation or defection) and vice versa. In the following discussion, we specify contracts in terms of actions, but one should keep in mind that this is without loss of generality.

Renegotiation. The owner and manager of each firm can at any time renegotiate the manager's compensation package. The decision to renegotiate is secret and not observed by the other firm unless the same investor owns both firms. The opportunity for renegotiation implies that equilibrium compensation contracts must be renegotiation-proof. Further, the ability to renegotiate in secret is important since it precludes the other firms from reacting. We assume that the owners have all the bargaining power and make take-it-or-leave-it offers to the managers (during the initial contracting stage and subsequent re-contracting). Finally, the outside option for each manager is normalized to zero.

3.2 Benchmark

We start by analyzing the case where each firm's owner is also its manager (in which case the value of θ is irrelevant). First, let each firm have a separate owner. In the unique equilibrium of the one-shot game, the firms behave uncooperatively, getting payoffs (π^N, π^N). By backward induction, the non-cooperative outcome also occurs if the game is repeated a finite number of times, with each firm getting a payoff $\sum_{t=0}^{T} \delta^t \pi^N$, where $T < \infty$ is the number of repetitions and δ the common discount factor.[11]

It is well-known that cooperation becomes easier to sustain when there is infinite repetition. (See Friedman (1971) and the "folk theorems" literature.) The firms can use trigger strategies: each firm cooperates until some firm defects. If ever such defection occurs, all firms immediately start behaving uncooperatively forever after. Such trigger strategies sustain cooperation if the following no-defection condition holds:

$$\frac{\pi^C}{1-\delta} \geq \tilde{\pi}^N + \delta \frac{\pi^N}{1-\delta},$$

[11] For simplicity, we assume all players have the same discount factor $\delta \in (0,1)$. One can think of δ as equal to $\mu\delta'$, where $\delta' \in (0,1)$ is a pure discount factor and $\mu \in [0,1]$ the probability that the game continues to period $t+1$ given that it reached period t.

The left-hand side is the firm's overall payoff from behaving cooperatively (the firm gets π^C each period). The right-hand side is the overall payoff from deviating and playing uncooperatively: the firm gets $\tilde{\pi}^N$ in the period of deviation followed by an overall payoff of $\pi^N/(1-\delta)$ during the (infinitely long) non-cooperative phase. The no-defection condition holds if and only if there is sufficiently little discounting of future payoffs:

$$\delta \geq \frac{\tilde{\pi}^N - \pi^C}{\tilde{\pi}^N - \pi^N} \equiv \delta_{min}.$$

If the above holds, each firm chooses to cooperate since the long-term loss from reverting to non-cooperative play (i.e., price war) outweighs the short-term gain from the deviation (note: $\delta_{min} \in (0,1)$). Reversion to non-cooperative play serves as a punishment for defectors. Moreover, the punishment is credible since it corresponds to the equilibrium of the one-shot game. In other words, the (tacit) collusive agreement is self-enforcing since it constitutes a subgame perfect equilibrium. Self-enforcement is essential since the courts generally do not enforce anti-competitive behavior (in many cases, explicit cartelization is illegal).

Next, let the firms have a common owner and assume that the cooperative outcome (i.e., both firms choosing C) maximizes their joint profits $2\pi^C > \tilde{\pi}^N + \tilde{\pi}^C$.[12] The common owner selects cooperation in both firms. Note that the common owner would promote collusion regardless of whether or not the game is repeated. The model's implication is thus unambiguous: common ownership has an anti-competitive effect, whereas separate owners promote collusion only if there is sufficiently little discounting. The same implication emerges if the firms are run by managers whose interests are perfectly aligned with those of the owners (in our case, this corresponds to $\theta = 0$). However, the situation becomes less clear-cut if the managers and the owners objectives are sufficiently miss-aligned, as we show next.

3.3 One-shot interaction

Suppose ownership control is separated and consider the one-shot interaction (we turn to repetition in Section 3.4). The main takeaway is that separate owners cannot sustain collusion in the one-shot game. In contrast, a common owner sustains cooperation under some circumstances, but not always. Next, we fill in the details. First, there is a separation of ownership and control, which implies that the owners cannot directly force the managers to take a particular action. Instead, the owners can influence the managerial incentives through the compensation plans, which can reward or penalize the manager for specific actions. However, due to limited liability, the managers cannot be forced to pay the owners (i.e., the manager's payoff cannot fall below zero).

[12]This need not be the case. For example, $\pi^C = 20$, $\pi^N = 15$, $\tilde{\pi}^N = 35$, and $\tilde{\pi}^C$ =6 constitute a Prisoner's dilemmas, but joint profits are maximized when one firm cooperates and the other defects. In such cases, the common owner selects C in one firm and N in the other. To simplify the exposition, we assume that both firms cooperating is the Pareto efficient outcome.

Collusive contracts. The owners induce the managers to behave cooperatively or uncooperatively through appropriate incentive schemes. We begin with the collusive contract. The cheapest way for the owners to induce collusion is to penalize competitive behavior to the maximum feasible extent. Suppose manager 1 is paid $r^C = \theta\tilde{\pi}^N$ for choosing C and not diverting and zero otherwise (i.e., for choosing N or diverting). Table 3 displays the payoffs from the perspective of manager 1, who chooses rows (manager 2, whose payoffs are omitted, chooses columns).

Collusive contract	C	N
C	$r^C + 0$	$r^C + 0$
N	$0 + \theta\tilde{\pi}^N$	$0 + \theta\pi^N$

Table 3

The first component in each cell is the manager's contractual payment, and the second is the amount he diverted. For example, choosing C and not diverting implies that the manager gets a contractual payment of $r^C = \theta\tilde{\pi}^N$. Note that cooperating becomes a weakly dominant strategy for any manager who is on the collusive contract r^C. Thus, putting both managers on the collusive contract implies that the cooperative equilibrium is unique.[13]

Non-collusive contracts. Next, we derive the no-collusive contract. The cheapest way for the owners to induce non-collusion is to penalize collusive behavior to the maximum feasible extent. Suppose manager 1 gets $r^N = \theta\pi^N$ for choosing N and not diverting and zero otherwise (i.e., for choosing C or diverting). Table 4 displays the payoffs from the perspective of manager 1, who chooses rows (manager 2, whose payoffs are omitted, chooses columns).

No-collusive contact	C	N
C	$0 + \theta\pi^C$	$0 + \theta\tilde{\pi}^C$
N	$0 + \theta\tilde{\pi}^N$	$r^N + 0$

Table 4

The first component in each cell is the manager's contractual payment, and the second is the amount he diverted. For example, choosing N and not diverting implies that manager 1 gets a contractual payment $r^N = \theta\pi^N$. The no-collusive contract r^N implies that not cooperating is a

[13]To see why, suppose firm 2 plays cooperatively (i.e., chooses C). Manager 1 gets $r^C + 0$ by choosing C and not diverting, $0 + \theta\pi^C$ by choosing C and diverting (recall: the manager is paid zero after diversion), $0 + 0$ by choosing N and not diverting, and $0 + \theta\tilde{\pi}^N$ by choosing N and diverting. Since $r^C = \theta\tilde{\pi}^N$, the manager best responds by choosing C and not diverting. Now, suppose firm 2 plays cooperatively (i.e., chooses N). Manager 1 gets $r^C + 0$ by choosing C and not diverting, $0 + \theta\tilde{\pi}^C$ by choosing C and diverting, $0 + 0$ by choosing N and not diverting, and $0 + \theta\pi^N$ by choosing N and diverting. Since $r^C = \theta\tilde{\pi}^N$ the manager again best responds by choosing C and not diverting.

weakly dominant strategy for manager 1 (and by symmetry, for manager 2). Thus, putting both managers on the no-collusive contract implies that the non-cooperative equilibrium is unique.

Separate owners. Suppose each firm has a separate owner. There are four players: managers 1 and 2 and owners 1 and 2. As we saw above, the managers can be induced to cooperate through appropriate contractual arrangements. However, separate owners have no incentive to offer collusive contracts implying that collusion in the one-shot interaction unravels. To see why, suppose each manager is initially put on the collusive contract (thus each manager gets $\theta\tilde{\pi}^N$ and each owner gets $\pi^C - \theta\tilde{\pi}^N$). However, just before the game starts, the owner and manager of firm 1 (the same holds for firm 2) can renegotiate as follows: manager 1 gets

$$\tilde{r}^N = \theta\tilde{\pi}^N + \epsilon$$

for choosing N and not diverting and zero otherwise (i.e., for choosing C or diverting). For ϵ small enough, $0 < \epsilon < \tilde{\pi}^N - \pi^C$, such an arrangement makes both the owner of firm 1 and its manager better off (the manager gets $\theta\tilde{\pi}^N + \epsilon > \theta\tilde{\pi}^N$ and the owner gets $\tilde{\pi}^N - \theta\tilde{\pi}^N - \epsilon > \pi^C - \theta\tilde{\pi}^N$) implying that firm 1 defects from the collusive agreement. Collusion unravels because the separate owners do not internalize that their higher profit from defecting comes at the expense of their rival.[14]

Common owner. Suppose both firms have the same owner. The players then are manager 1, manager 2, and the common owner. Each manager cooperates when put on the collusive contract r^C and does not cooperate when put on the no-collusive contract r^N. By putting each manager on the collusive contract the common owner gets $2(\pi^C - r^C)$ (i.e., $\pi^C - r^C$ from each firm). By putting each manager on the no-collusive contract, he gets $2(\pi^N - r^N)$. Thus, the common owner promotes collusion whenever it is self-financing: the total monetary gains exceed the extra payment given to the managers to collude

$$\pi^C - \pi^N > r^C - r^N.$$

Inserting $r^N = \theta\pi^N$ and $r^C = \theta\tilde{\pi}^N$ into the above and rearranging implies that collusion is self-financing whenever

$$\theta < \frac{\pi^C - \pi^N}{\tilde{\pi}^N - \pi^N} \equiv \theta_{max}.$$

Note that $\theta_{max} \in (0, 1)$. Even a common owner does not always promote collusion. The reason is that sustaining collusion is costly: each manager will be tempted to defect, get cash flows $\tilde{\pi}^N$, and divert an amount $\theta\tilde{\pi}^N$. To deter such behavior, the manager must be paid $\theta\tilde{\pi}^N$ rather than $\theta\pi^C$

[14]The above assumes that renegotiations are secret. If renegotiations were not secret, cooperation could be sustained as follows. Each manager is put on the collusive contract r^C. If one firm attempts to renegotiate, the managers of all other firms are put on the no-collusive contract r^N. The firms recognize that renegotiate attempts would unravel cooperation leaving everyone worse off. However, such contractual arrangements are not feasible if renegotiations can be carried in secret.

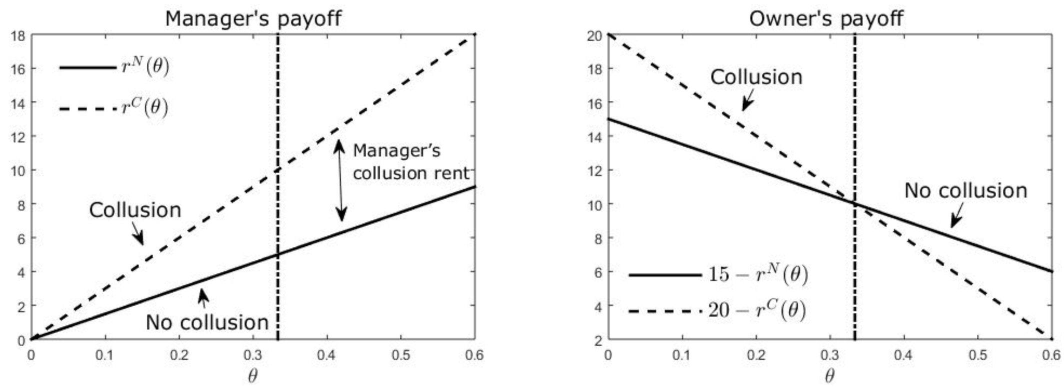


Figure 2: Panel (a) displays each manager's payoff under non-collusive contract r^N, and collusive contract r^C as a function of the agency cost θ. The difference between r^C and r^N is the manager's collusion rent. Panel (b) displays the common owner's payoff per firm when the managers are colluding $\pi^C - r^C$, and when the managers are competing $\pi^N - r^N$, as functions of θ. If the agency cost is below a threshold, the common owner puts the managers on collusive contracts - causing them to cooperate.

(i.e., $\theta\pi^C$ plus a collusion bonus $\theta(\tilde{\pi}^N - \pi^C)$). In other words, each manager must be compensated for the foregone diversion opportunity. If θ is too large (i.e., $\theta > \theta_{min}$), the common owner earns greater profit by forsaking cooperation and putting both managers on the no-collusive contract (and thus not giving them collusion bonuses).

Panel (a) on Figure 2 displays the manager's payoff as a function of θ with and without collusion. The remaining parameters are as in the example in Table 2. The managerial collusion rent increases in θ. Panel (b) on the figure displays the common owner's payoff per firm. The common owner only puts the managers on the collusive contract for moderate agency costs: if θ is less than 1/3. For θ greater than 1/3, the common owner abandons collusion and induces the managers to compete. Thus, severe agency costs hinder collusion under a common owner.

3.4 Repeated interaction

Suppose the game is repeated in periods $t \in \{0, 1, 2, ..., \}$. The main takeaway of this section is that collusion becomes easier for separate owners but not for a common owner. To explain why we first need to introduce a new contractual arrangement made possible by repetition, namely trigger contracts.

Trigger contracts. It is well-known that repetition makes collusion easier through trigger strategies. All firms start by cooperating. If ever one firm behaves uncooperatively, all firms play uncooperatively after that. In our case, there is a separation of ownership and control. Thus, the managers must be induced to play trigger strategies through appropriate contracts, and the owners must have an incentive to put the manager of their firm on such a contract. First, define the following static contracts:

- Collusive contract r^C: the manager gets $r^C \geq 0$ for choosing C and not diverting and zero for either choosing N or diverting.
- Non-collusive contract r^N: the manager gets $r^N \geq 0$ for choosing N and not diverting and zero for either choosing C or diverting.

The above contracts are static since they do not depend on the history of the game. The managers are induced to play trigger strategies as follows: each manager is initially put on r^C. If ever one firm defects, all managers are put on r^N. We refer to $T(r^C, r^N)$ as the trigger contract since it induces the managers to play trigger strategies. Suppose both managers are put on $T(r^C, r^N)$. Table 5 displays the payoff matrix from the perspective of manager 1 choosing rows (manager 2 chooses columns, and his payoffs are omitted for brevity).

Trigger contract	C	N
C	$r^C + \delta \frac{r_T^C}{1-\delta}$	$r^C + \delta \frac{r^N}{1-\delta}$
N	$\theta\tilde{\pi}^N + \delta \frac{r^N}{1-\delta}$	$\theta\pi^N + \delta \frac{r^N}{1-\delta}$

Table 5

First, the manager can set C and then divert $\theta\pi^C$. The manager must be given at least $\theta\pi^C$ each period to prevent this from happening. That is, the trigger contract $T(r_T^C, r^N)$ must satisfy the following no-diversion condition:

$$r^C \geq \theta\pi^C. \tag{1}$$

Second, the manager can set N and divert $\theta\tilde{\pi}^N$. However, doing so triggers reversion to non-cooperative play where the manager earns r^N in each subsequent period. Thus, the trigger contract must satisfy the following no-defection condition:

$$\frac{r^C}{1-\delta} \geq \theta\tilde{\pi}^N + \delta \frac{r^N}{1-\delta}. \tag{2}$$

Panel (a) on Figure 3 displays the manager's flow payoff as a function of δ. For low values of δ, the manager's no-defection condition is harder to satisfy than the no-diversion condition, and the manager earns strategic rents $r^C > \theta\pi^C$. For high values of δ, the no diversion condition becomes harder to satisfy, and the manager no longer obtains strategic rents $r^C = \theta\pi^C$.

Separate ownership. Suppose each firm is separately owned and put all managers on the trigger contract $T(r^C,\, r^N)$. We established above that the trigger contract must satisfy the conditions in (1) and (2), and now we derive conditions guaranteeing that trigger strategies constitute an SPNE under separate ownership. First, suppose a defection has taken place in period t and consider the subsequent period $t+1$. Each separate owner puts the manager of his firm on the non-collusive contract r^N since he expects the other owner to do the same. The owner gets a flow payoff of $\pi^N - r^N$, and the manager receives a flow payoff of r^N. Thus, the punishment phase (i.e., aggressive competition and low profits) is credible since it constitutes equilibrium.

Second, the owner can induce the manager to defect by renegotiating the trigger contract $T(r^C,\, r^N)$. Each owner can cause the manager of his firm to deviate from the collusive agreement as follows: the manager is paid $\tilde{r}^N$ for choosing N and not diverting and zero otherwise. The manager anticipates that a defection triggers reversion to non-cooperative play, which implies that $\tilde{r}^N$ must be set so that $r^C/(1-\delta) = \tilde{r}^N + \delta r^N/(1-\delta)$. The no-defection condition for each firm's owner is given by

$$\frac{\pi^C - r^C}{1-\delta} \geq \tilde{\pi}^N - \tilde{r}^N + \delta\frac{\pi^N - r^N}{1-\delta}. \tag{3}$$

The left-hand side is the owner's overall payoff on the collusive path. The right-hand side is his overall payoff after causing the manager to defect through contract renegotiation. The owner anticipates that causing a defection triggers retaliation by the other firm. Thus, he gets $\tilde{\pi}^N - \tilde{r}^N$ in the period of defection and $\pi^N - r^N$ in each subsequent period. The above no-defection condition is satisfied if the discount factor δ exceeds the threshold δ_{min} given by

$$\delta_{min} \equiv \frac{\tilde{\pi}^N - \pi^C}{\tilde{\pi}^N - \pi^N}.$$

Stated differently, the maximum the owner of firm 1 gets by inducing manager 1 to play uncooperatively is $(1-\theta)\tilde{\pi}^N$ in the period of the defection followed by $(1-\theta)\pi^N$ in each subsequent period. For $\delta \geq \delta_{min}$ the owner gets a higher overall payoff from sticking to the collusive agreement. Panel (b) in Figure 3 shows separate owners incentives to follow the collusive agreement or induce the manager to defect. If δ falls below the threshold δ_{min}, each separate owner has an incentive to cause defection. As a result, collusion in trigger strategies cannot be sustained. On the other hand, if δ lies above the threshold, each separate owner prefers to stick to the collusive agreement, which implies that collusion in trigger strategies can be sustained.

Common ownership. Suppose the two firms have the same owner. We show that the common owner cannot rely on trigger strategies to induce cooperation. In particular, for trigger contracts to work, each manager must expect retaliation after a defection. Suppose one manager defects by setting N and diverting $\theta\tilde{\pi}^N$ in the current period. Note that each manager gets a contractual

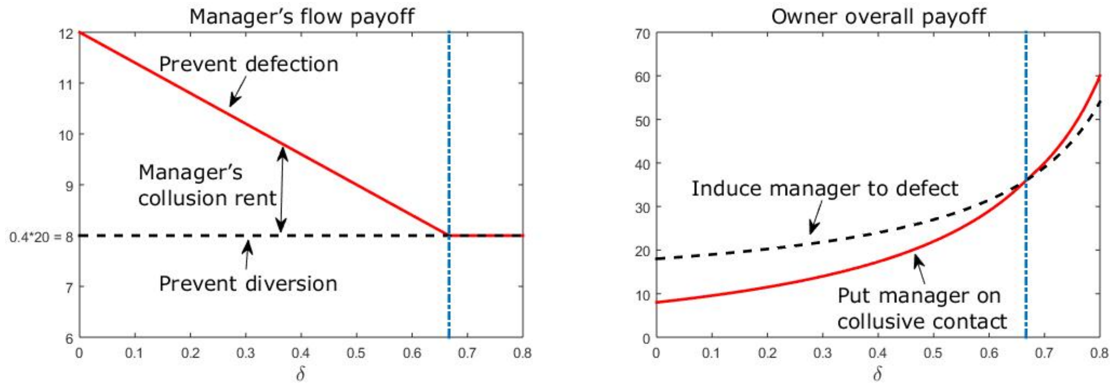


Figure 3: Panel (a) shows each manager's flow payoff under the trigger contract $T(r^C, r^N)$ as a function of δ (the manager's overall payoff is $r^C/(1-\delta)$). The trigger contract must ensure that the manager does not divert $r^C \geq \theta\pi^C$ and not defect $r^C/(1-\delta) \geq \theta\tilde{\pi}^N + \delta r^N/(1-\delta)$. The manager's collusion rent (i.e., the difference between r^C and $\theta\pi^C$) decreases in δ. Panel (b) shows each separate owner's overall payoff of the collusive agreement $(\pi^C - r^C)/(1-\delta)$ and his maximum overall payoff from inducing the manager to defect $(1-\theta)\tilde{\pi}^N + \delta(\pi^N - r^N)/(1-\delta)$. Each owner puts the manager on the trigger contract only if the discount factor is above a threshold.

payment of zero for choosing N, so the optimal action is to divert after a defection.

To determine whether this defection is profitable, the manager must consider the common owner's reaction. If in response, the common owner puts the managers on the non-collusive contract r^N the manager gets $\theta\tilde{\pi}^N$ in the period of the defection and an overall payoff of $\delta r^N/(1-\delta)$ in the subsequent periods. Since $r^C > r^N$ the manager prefers not to defect as long as there is sufficiently little discounting (i.e., δ close enough to one).

However, one must take into account the common owner's incentive after a defection. The common owner's overall payoff depends on the managers equilibrium behavior on a particular contract profile. The question is how the managers would react if the common owner attempts to restart the collusive agreement by putting both managers on r^C (i.e., the first component of $T(r^C, r^N)$).

If more than one SPNE is associated with a given managerial contract profile, we assume the managers coordinate on the most collusive SPNE. Thus, if trigger contracts can be used to induce cooperation in period t, then they can be used to induce cooperation in subsequent periods. By putting both managers on the non-collusive contract r^N the common owner gets an overall payoff of $U^N = 2(1-\theta)\pi^N/(1-\delta)$. The common owner's overall payoff from putting the managers on trigger contract is $U^C = 2(1-\theta)\pi^C/(1-\delta)$.

Since $U^C > U^N$ the common owner lets "bygones be bygone" and restarts the collusive agreement by again putting each manager on the contract r^C. That is, each manager is given the collusive contract even after defecting. However, if the managers do not expect retaliation after defection,

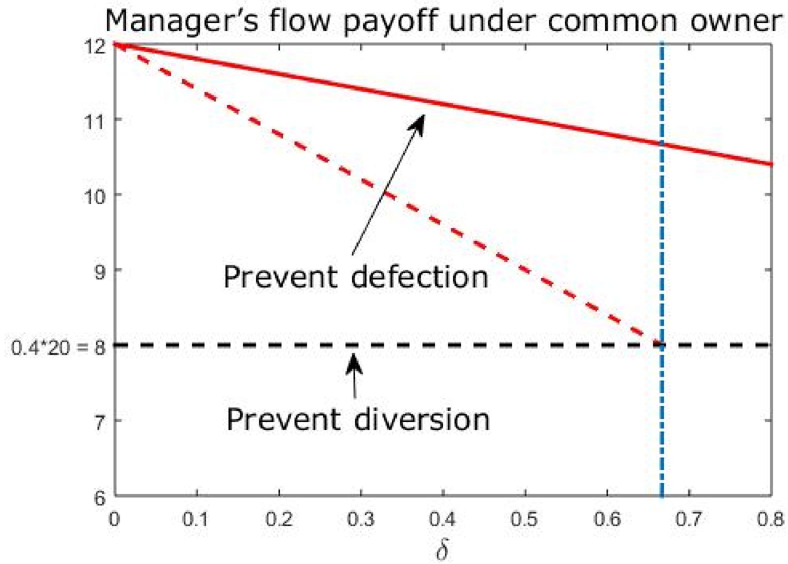


Figure 4: The managers earn greater rent for cooperating under a common owner (solid red line) compared to separate owners (dashed red line). The reason is that a common owner has a commitment problem and, even after defection, prefers to steer the firms towards competing less aggressively.

then the trigger contract will not induce cooperation unless $r^C = \theta\tilde{\pi}^N$ (since the manager's no defection condition is $r^C + \delta V^C \geq \theta\tilde{\pi}^N + \delta V^C$). Note that $\theta\tilde{\pi}^N$ is the same collusion bonus as in the one-shot game. Thus, any gain from repeated interaction evaporates due to the common owner's unwillingness to cause non-cooperative behavior after defections.

The above discussion ruled out situations where a defection in period t triggers pessimistic expectations, preventing reversing the original equilibrium path. More generally, assume that after defection, the common owner restores the original collusive agreement with probability q. Each manager's penalty for defection is inversely related to q. Note that r^C increases in q for each δ. This situation is illustrated in Figure 4, where after a defection, the common owner restores collusion with probability $q > 0$.

3.5 Implications

This section summarizes the model implications.

When does common ownership increase collusion? The analysis shows that common ownership can increase or decrease collision relative to separate ownership depending on industry characteristics such as δ and θ. Figure 5 summarizes the predicted effect of moving from separate to common ownership - holding everything else constant. The main takeaway is that common owners decrease collusion in industries with a high natural predisposition toward collusion (i.e., high δ). At the same time, common owners increase collusion in industries with low agency costs (i.e., low θ). The following section uses the heterogeneous effect of common ownership on product-market outcomes to test the model.

- (I) If $\theta \leq \theta_{max}$ and $\delta \geq \delta_{min}$ then collusion can take place both under separate owners and under a common owner. Moving from separate to a common owner leaves firm profits unchanged and equal to π^C. However, it increases managerial compensation from $\theta\pi^C$ to $\theta\tilde{\pi}^N$ (i.e., the managers earns higher rents). The increase in the managerial compensation is proportional to the amount they can divert θ.

- (II) If $\theta > \theta_{max}$ and $\delta \geq \delta_{min}$ then collusion can take place under separate but not under a common owner. Moving from separate to common ownership decreases firm profit (from π^C to π^N) and managerial compensation (from $\theta\pi^C$ to $\theta\pi^N$). Thus, firm profits and managerial compensation are greater under separate ownership (since this is when collusion occurs).

- (III) If $\theta \leq \theta_{max}$ and $\delta < \delta_{min}$ then collusion can take place under a common owner but not under separate owners. In this case, moving from separate to common ownership increases firm profit (from π^N to π^C) and managerial compensation (from $\theta\pi^N$ to $\theta\tilde{\pi}^N$). Note that the managerial compensation increase more than one-to-one with firm profit, reflecting managerial collusion rents due to the common owner's inability to use trigger strategies.

- (IV) Finally, if $\theta > \theta_{max}$ and $\delta < \delta_{min}$ then collusion will not take place under each type of ownership. As a result, moving from separate to common ownership leaves both profits and managerial compensation unchanged.

The discussion in this section is subject to several caveats. (i) The question we are after is whether collusion can be implemented as a subgame perfect equilibrium. As is usual in repeated games, the equilibrium is generally not unique. (ii) We abstract from general equilibrium implications such as firm entry, exit, and predatory behavior. (iii) In line with the common ownership literature, we compare different ownership arrangements but do not consider the equilibrium determination of ownership patterns.

Managerial compensation. The model can shed light on some features of managerial compensation and how they relate to common ownership. Specifically, the structure of the managerial compensation depends not only on whether the firms are colluding but also on the ownership type. Separate owners promote anti-competitive behavior through trigger strategies (i.e., penalties for defections). Trigger strategies imply that the managers are rewarded for maximizing firm value. The reason is that defection increases the firm's short-term profits, but at the same time, it also

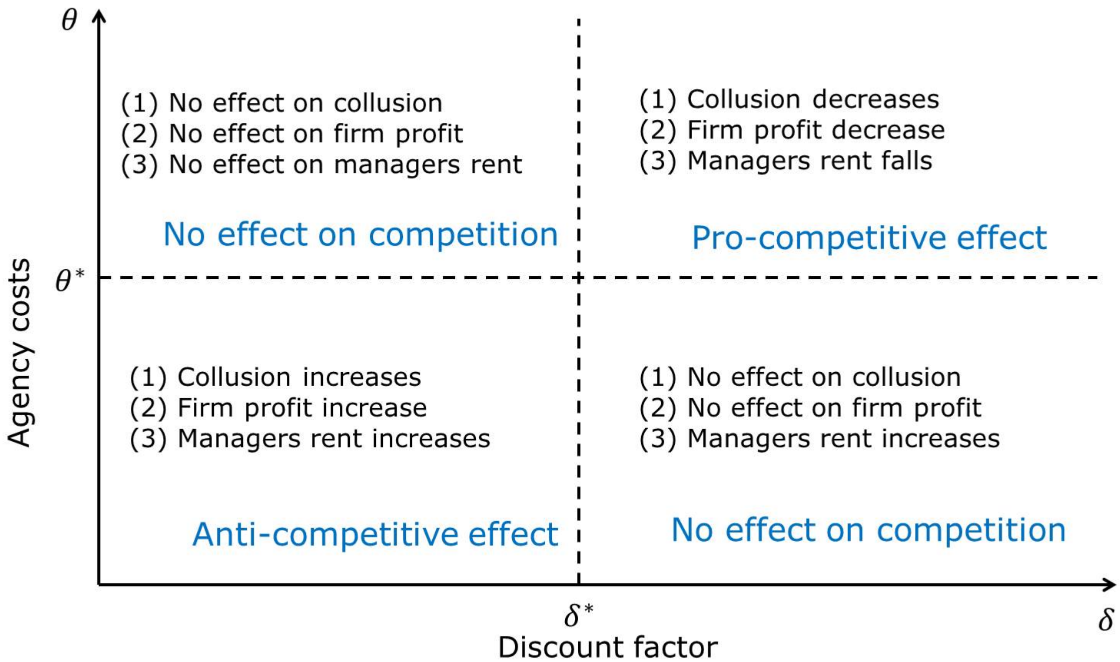


Figure 5: Model predictions: moving from separate to common ownership.

decreases the firm's long-term capitalized loss by an even greater amount. Thus, high-powered incentives (i.e., those based on firm rather than industry performance) do not always imply that the firms are behaving competitively.

In contrast, common owners cannot rely on trigger strategies (at least much less so than separate owners). As a result, collusion under common owners occurs if the managers are compensated based on industry rather than firm performance. That is, common owners promote collusion through low-powered incentive schemes. Thus, relying on low-powered managerial incentives as a collusion indicator could overestimate the anti-competitive effect of common ownership since it ignores that separate owners attain collusion through high-powered incentives in this setup. This is especially likely to be the case in high δ industries where both separate and common owners can sustain collusive behavior.

Reducing agency costs. The players generally have a stronger incentive to reduce financial frictions (i.e., lower θ) under common ownership. Specifically, mitigating financial frictions can be Pareto improving under common, but not under separate ownership. Refer back to our motivating example in Table 1, where $\tilde{\pi}^N = 30$, $\pi^C = 20$, $\pi^N = 15$, and $\theta = \frac{4}{10}$ (thus $\theta_{max} = \frac{1}{3}$). Recall: $r^N = \frac{4}{10}15 = 6$ and $r^C = \frac{4}{10}30 = 12$. Since $\pi^C - \pi^N < r^C - r^N$ collusion is not self-financing, and the common owner puts the managers on the no-collusive contract. Each manager gets $r^N = 6$, and the common owner gets $2(\pi^N - r^N) = 18$.

Note that reducing θ from $\frac{4}{10}$ to say $\frac{3}{10}$ (i.e., through better monitoring technology) implies that collusion becomes self-financing, and all parties earn greater payoffs (each manager get $r^C = \frac{3}{10}30 = 9$ and the common owner gets $2(\pi^C - r^C) = 22$). This outcome is illustrated in Figure 6, with panel (a) showing the managers payoff and panels (b) the common owner's payoff. Thus, improved firm governance can have an anti-competitive effect. In general, reducing agency costs from θ to $\theta - \epsilon$ increases collusion under common ownership whenever the following holds

$$\theta(\tilde{\pi}^N - \pi^N) > \pi^C - \pi^N > \theta(\tilde{\pi}^N - \pi^N) - \epsilon\tilde{\pi}^N > 0$$

The first inequality implies that collusion will not emerge if the agency cost is θ. That is, each manager is put on the non-collusive contract $r^N = \theta\pi^N$). The second inequality implies that collusion emerges if the agency cost is $\theta - \epsilon$. That is, each manager is put on the collusive contract $r^C = \theta\tilde{\pi}^N$. The third inequality implies that each manager earn a greater amount under collusion $(\theta - \epsilon)\tilde{\pi}^N > \pi^N$.

At the same time, reducing θ under separate ownership redistributes surplus from the manager to the owner without changing the equilibrium (i.e., the firms still do not cooperate). Stated differently, lowering agency costs is against the managers' interest unless they can be offered a fraction of the firm's increased collusion profits.

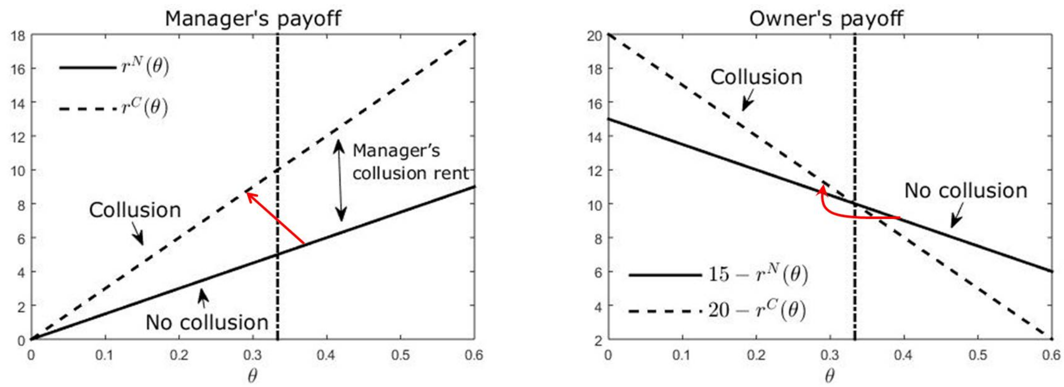


Figure 6: Anti-competitive effects of improved firm governance.

4 Empirics

4.1 Empirical Framework

We test the main predictions of our model by running the following regression:

$$Y_{i,t} = \alpha_i + \gamma_t + \beta_1 \text{CO}_{i,t-1} \cdot \delta_L \cdot \theta_H + \beta_2 \text{CO}_{i,t-1} \cdot \delta_H \cdot \theta_H +$$
$$\beta_3 \text{CO}_{i,t-1} \cdot \delta_L \cdot \theta_L + \beta_4 \text{CO}_{i,t-1} \cdot \delta_H \cdot \theta_L + \beta X_{i,t-1} \epsilon_{i,t}$$

with i indicating industries, δ_H, δ_L, θ_H, θ_L dummy variables indicating high and low values of δ and θ, $X_{i,t-1}$ a matrix of time-varying industry controls, and CO measuring common ownership. We study two different outcome variables, $Y_{i,t}$: first, industry profitability, which could indicate the presence of collusive behavior and, second, total CEO compensation as a proxy for the share of profits going management. We lag all dependent variable by one year because we expect a delay between the potential implementation of any measure affecting competition and their effect. Each coefficient, β_1 to β_4, measures the impact of a change in common ownership on profitability and managerial compensation in one of the quadrants in Figure 5, allowing us to directly test the main predictions of our model.

We also test the impact of δ and θ separately by running the following two regressions:

$$Y_{i,t} = \alpha_i + \gamma_t + \beta_1 \text{CO}_{i,t-1} \cdot \theta_H + \beta_2 \text{CO}_{i,t-1} \cdot \theta_L + \beta X_{i,t-1} \epsilon_{i,t}$$

$$Y_{i,t} = \alpha_i + \gamma_t + \beta_1 \text{CO}_{i,t-1} \cdot \delta_L + \beta_2 \text{CO}_{i,t-1} \cdot \delta_H + \beta X_{i,t-1} \epsilon_{i,t}$$

Since we rely on proxy variables for θ and δ a separte estimation of the effect of each allows us to circumvent potential problems in the other proxy variable. The regression including only θ also corresponds to a separate test of the One-shot interaction model of Section 3.3.

4.2 Data and Descriptive Statistics

We use COMPUSTAT data of US firms to test the main predictions of our model. Our data treatment follows Koch et al. (2021), whose data about common ownerhsip we use. We keep firms with total assets larger than 1m and sales larger than 0.25m, and exclude firms with larger sales than EBIT. We then compute annual firm-level markup as $\frac{Sales}{Sales-EBIT}$, where EBIT is earnings before interest and taxes, and price-cost-margin as $\frac{Sales-\text{Cost of goods sold}+\Delta Inventories}{Sales+\Delta Inventories}$. For the subset of firms with data on executive compensation we also compute annual CEO pay as $\frac{\text{Total Compensation}}{\text{Firm Value}}$.[15] All firm level variables are trimmed at 1% and then aggregated to the industry level. We trim dependent variables again at the industry-level.

Common ownership We measure common ownership as stock ownership concentration in a SIC three-digit industry using the five different measures computed by Koch et al. (2021).[16] We aggregate their data to the annual level to avoid high-frequency changes in common ownership in the quarterly data. We only use the SIC industry classification because there appears to be a gap in 2001/2002 for a lot of NAICS industries and our measure of δ is only available in SIC format.

Industry δ The industry δ measures the discount factor in a given industry, indicating how difficult collusion is to sustain in that industry. While we could have computed a measure of δ based on variables influencing the likelihood of collusion, there is little guidance[17] by the theoretical industrial organization literature on how build such a measure and doing so, would have involved

[15]We follow Liang (2016) and restrict the sample to CEOs using the variable CEOANN. We scale total annual flow compensation (TDC1) including salary, bonus and other annual compensation by a firm's market value or alternatively by a firm's book value of assets. Finally, we take the natural logarithm of this ratio.

[16]Data are kindly provided by the authors on Andrew Koch's webpage https://sites.pitt.edu/ awkoch/CommonOwnershipData.html

[17]Asker and Nocke (2021) write that "[...], while the theoretical literature on the factors that facilitate collusion continues to grow, the predictive power of the theoretical framework is poor and the mapping of theory to empirics not very well developed."

a lot of discretion. Instead, we use a list of industries identified as especially collusion-prone by Grout and Sonderegger (2005).[18] Grout and Sonderegger (2005) fit a predicitive model using detected cartel cases from the European Commission 1990-2005 and from the US Department of Justice 1994-2005 with industry specific variables as predictors. These variables include industry turnover, demand volatility, entry barriers and concentration indices among others. They then use the coefficients to predict the likelihood of a cartel for all industries, i.e. industries with and without detected cartel cases.

Industry θ The industry θ measures the severity of the agency friction between shareholders and managers. In our model θ is the fraction of current profits managers can divert funds. We use cross-industry differences of the well-known Gompers et al. (2003) Index of corporate governance as a proxy variable. A higher value of the index indicates more power of the management relative to shareholders. We compute the median index value for each industry across time. Appendix Figure A1 shows the index for SIC two-digit industries. Industry θs vary considerably across SIC three-digit industry, as shown in Figure A2. When aggregating to the SIC one-digit level we find that the manufacturing industry has the worst corporate governance provisions compared to other industries. This is consistent with the 2020 American Corporate Governance Index.[19] Furthermore, Gillan et al. (2003) argue that industry related factors play an important role for a firm's overall corporate governance quality.

Descriptive Statistics Table 6 presents summary statistics of all variables. 20% of observations in our sample belong to the 52 (out of a total of 256 industries) collusion-prone industries identified by Grout and Sonderegger (2005), labeled as $\delta = \delta_H$. 34% of observations from 87 industries are in the bottom tercile of the median Gompers et al. (2003) index, labeled as $\theta = \theta_L$. The distribution of the common ownership measures as well as markup and the price-cost margin are very similar to Koch et al. (2021). The correlation of the different measures of common ownership is relatively low, ranging between 0.06 and 0.78.

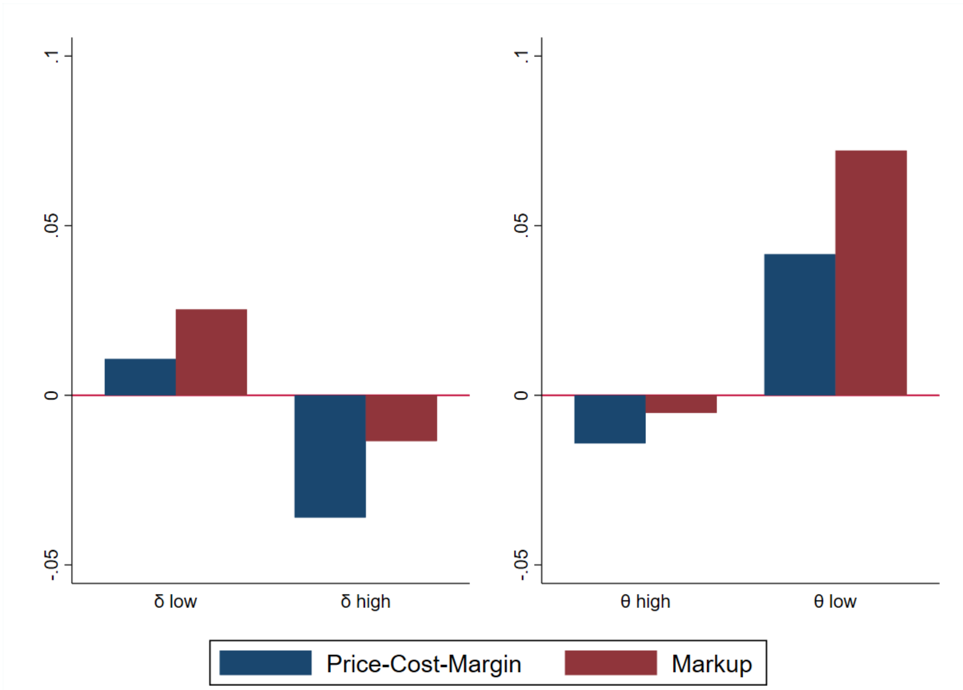
4.3 Results

We start by investigating whether large increases in common ownership have a different impact depending on whether an industry is characterized by a high or low θ or δ. Figure 7 shows average growth rates of markup and price-cost-margins one year after a large increase in density. Density measures the share of firm-pairs in an industry connected by a common owner. We plot growth

[18]Table 3 in Grout and Sonderegger (2007) lists the 30 SIC three-digit industries where collusion is most likely to occur. Because their SIC classification differs slightly from our version we have translate their table into current SIC three-digit codes. The translation is shown in Appendix Table A1

[19]Published by the Institute of Internal Auditors https://na.theiia.org/about-us/Pages/American-Corporate-Governance-Index.aspx

Figure 7: Industry Profitability Growth after Large Increases in Density



Notes: Average growth of industry price-cost-margin and markup after large increases in common ownerhship measured by density. Markup growth has been multiplied by 10 to allow for a comparable scale. Large increases are defined as changes larger than the average change in density plus two standard deviations at the industry level. High δ are industries defined as collusion-prone by Grout and Sonderegger (2005). Low θ are industries, whose median Gompers et al. (2003) index of corporate governance is in the bottom tercile.

rates separately for industries with high and low θ or δ. The left-hand-side panel shows slightly increasing industry profitability for low δ industries and decreasing profitability for high δ industries. As a comparison, the average price-cost-margin growth is 6% in the entire sample, whereas price-cost-margins decrease by 4% after large increases in density in high δ industries. When splitting the sample of increases in density by θ, we find profitability to increase in low θ industries and decreases in profitability in high θ industries. Both results are in line with the predictions of our model summarized in Figure 5.

We now turn to regression analysis, where we use all five variables measuring common ownership, add industry and time fixed effects to control for time-invariant differences in common ownership across industries and common shocks, and add time-varying industry level controls. Table 7 shows the main regression results: there are five columns for each dependent variable, one for each of the different measures of common ownership. The top panel in Table 7 shows results for the two measures of industry profitability as a dependent variable. All but one estimate in the second row have the expected positive sign, and five are also statistically significant, indicating that increases in common ownership have pro-competitive effects in industries characterized by a high discount factor and strong agency frictions. For the third row of Table 7, our model predicts a positive coefficient. All estimates in the third row are positive and four also statistically significant. The estimates in the first and last row, where our model predicts that increases in common ownership should have no effect, have mixed signs and only two of them are statistically significant.

In the bottom panel of Table 7 we test the implications of our model for managerial compensation. We do not find evidence for a pro-competitive effect of common ownerhship in the second row, where none of the estimates is statistically significant and the signs vary across columns. We do, however, find that increases in common ownership may lead to higher managerial compensation when θ is low. All but two coefficients in the third and fourth row have the expected positive sign and seven are also statistically significant.

We separately test the impact of δ and θ on industry profitability in Appendix Table A2 and on managerial compensation in Appendix Table A3. The results are very similar to the results above: most estimates have the expected sign, some of them are statistically significant, with only one statistically significant estimate going in the opposite direction of the model prediction.

While we do not attempt to address potential endogeneity issues in our regression our empirical results provide support for the main predictions of our model. We find evidence for the predicted pro- and anti-competitive effects in the data even though not all the estimates are statistically significant.[20]

5 Conclusion

The significant increase in common ownership of horizontal competitors has sparked a debate on its possible anti-competitive effects in recent years. While increased common ownership unambiguously increases firm collusion in most models, the empirical evidence is inconclusive. We analyze the impact of common ownership in a model featuring dynamic competition, separation of ownership and control, and agency costs. While highly stylized, the model provides novel insights and delivers predictions to shed light on the mixed empirical evidence.

The main takeaway is that common owners are plagued by "renegotiation problems" stemming from their eagerness to avoid competitive behavior. The renegotiation problem affects the credibility of the common owner and prevents the use of threats - such as reverting to cutthroat competition - to deter managerial defections. An alternative reaction is not to revert to cutthroat competition but

[20]External factors, such as import competition from abroad or the presence of a "maverick" privately held firm, are potentially attenuating any effect we find in the data.

to fire the incumbent management. However, such a threat is not credible if replacing management carries a cost for the owners.

Separate owners are not immune to renegotiation incentives - as a group, they prefer to avoid price wars. However, such renegotiations become more likely as the prevalence of common ownership within an industry increases. Thus, we emphasize the role of limited commitment and agency costs (such as managerial opportunism) and show that both ingredients are necessary if a common owner increases collusion in some cases and decreases it in others. Specifically, we show that reducing agency costs benefits common owners (in terms of their capacity to sustain collusion) more than separate owners.

The model delivers novel empirical predictions. Specifically, by conditioning the effect of common ownership on industry characteristics, the model can account for some of the heterogeneous impacts of common ownership found in the literature. First, common ownership tends to decrease collusion in industries with a high natural predisposition towards collusion. Second, common ownership tends to increase collusion in industries with low agency costs. We provide empirical evidence consistent with these predictions.

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Figures and Tables

Table 6: Summary Statistics

	Mean	P25	Median	P75	N
$\delta = \delta_H$	0.20	0.00	0.00	0.00	5572
$\theta = \theta_L$	0.34	0.00	0.00	1.00	5572
$\theta = \theta_L$ & $\delta = \delta_H$	0.05	0.00	0.00	0.00	5572
Common Ownership					
Density	0.09	0.01	0.05	0.12	5572
PCF	0.16	0.04	0.15	0.24	5572
PCS	0.28	0.17	0.25	0.35	5572
MHHIΔ	0.14	0.07	0.13	0.19	5572
C	0.16	0.10	0.15	0.20	5572
Outcome Variables					
Markup	1.09	1.02	1.06	1.11	5572
Price-Cost-Margin	0.31	0.24	0.31	0.39	5572
Log Compensation/Assets	−6.21	−6.70	−6.13	−5.60	4357
Log Compensation/Market Value	−6.65	−7.12	−6.57	−6.12	4272
Controls					
Log Assets	9.65	8.36	9.60	10.86	5572
1/Number of Firms	0.10	0.04	0.07	0.14	5572
HHI	0.28	0.14	0.23	0.36	5572
Capital Intensity	1.57	0.71	1.01	1.47	5572
Sales Growth	0.08	−0.02	0.07	0.17	5572
R&D Intensity	0.01	0.00	0.00	0.01	5572
R&D Missing	0.29	0.00	0.00	1.00	5572
Leverage	0.32	0.16	0.28	0.44	5572

Summary statistics for the baseline regression sample. Annual industry-level data from US public firm in 264 SIC three-digit industries from 1988 until 2012. $\delta = \delta_H$ are collusion-prone industries taken from Grout and Sonderegger (2005), $\theta = \theta_L$ is the bottom tercile among industry medians of the Gompers et al. (2003) index of corporate governance. The common ownership measures and the definitions of the control variables are from Koch et al. (2021). All common ownership and control variables are lagged.

Table 7: Interaction

Top Panel: Industry Profitability	DV: Industry Price-Cost Margin					DV: Industry Markup				
	Density	PCF	PCS	MHHIΔ	C	Density	PCF	PCS	MHHIΔ	C
CO x δ_L x θ_H (.)	−0.02	−0.01	−0.02	0.01	−0.02	0.01	0.03	0.03	0.08**	0.06**
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)
CO x δ_H x θ_H (-)	−0.06***	−0.06*	−0.03	−0.11**	−0.11**	−0.06**	−0.03	−0.04	0.06	−0.08
	(0.02)	(0.03)	(0.03)	(0.06)	(0.04)	(0.03)	(0.05)	(0.03)	(0.07)	(0.06)
CO x δ_L x θ_L (+)	0.02	0.05**	0.04*	0.06	0.07***	0.02	0.04	0.05***	0.05	0.03
	(0.02)	(0.02)	(0.02)	(0.05)	(0.03)	(0.02)	(0.03)	(0.02)	(0.06)	(0.03)
CO x δ_H x θ_L (.)	−0.05	−0.01	−0.07	0.09	−0.06	−0.05	0.01	−0.02	0.04	−0.00
	(0.06)	(0.06)	(0.06)	(0.09)	(0.09)	(0.09)	(0.07)	(0.09)	(0.09)	(0.17)
R^2	0.72	0.72	0.72	0.72	0.72	0.73	0.73	0.73	0.73	0.73
Observations	5572	5572	5572	5572	5572	5572	5572	5572	5572	5572
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bottom Panel: CEO Compensation	DV: Log(Compensation/Market Value)					DV: Log(Compensation/Assets)				
	Density	PCF	PCS	MHHIΔ	C	Density	PCF	PCS	MHHIΔ	C
CO x δ_L x θ_H (.)	−0.06	−0.13	−0.02	−0.29	−0.18	0.05	−0.08	0.09	−0.63**	−0.11
	(0.17)	(0.21)	(0.19)	(0.34)	(0.26)	(0.15)	(0.16)	(0.17)	(0.31)	(0.25)
CO x δ_H x θ_H (-)	0.07	−0.17	0.22	−0.58	−0.51	0.01	−0.09	0.17	−0.27	−0.47
	(0.20)	(0.49)	(0.28)	(0.64)	(0.51)	(0.26)	(0.46)	(0.32)	(0.50)	(0.58)
CO x δ_L x θ_L (+)	0.26	0.38	0.43**	−0.30	0.57**	0.44***	0.89***	0.49***	−0.41	0.21
	(0.21)	(0.23)	(0.19)	(0.47)	(0.29)	(0.15)	(0.21)	(0.18)	(0.50)	(0.33)
CO x δ_H x θ_L (+)	0.54**	0.47	0.41	1.09	0.28	0.31	0.48	0.26	1.27**	0.17
	(0.25)	(0.71)	(0.49)	(0.71)	(0.38)	(0.35)	(0.76)	(0.47)	(0.53)	(0.42)
R^2	0.63	0.63	0.63	0.63	0.63	0.58	0.58	0.58	0.58	0.58
Observations	4354	4354	4354	4354	4354	4270	4270	4270	4270	4270
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Panel regressions of annual industry price-cost-margin, industry markup, and total CEO compensation on five different measures of common ownerhship interacted with indicators for δ_L, δ_H and θ_L, θ_H or a combination. (+) indicates a positive sign predicted by our model, (-) a negative sign, and (.) no effect. All regressions include year and industry fixed effects. All dependent variables are lagged. Control variables: log assets, leverage, capital intensity, r&d intensity, indicator for only missing r&d expenditures, sales growth, HH-index, the inverse of the number of firms. Data are from US public firms 1988-2012 aggregated to the three-digit SIC industry level. Robust standard errors clustered at the SIC three-digit level in parentheses.

A Appendix

A.1 Alternative model specification

We show that the key implications are robust to alternative assumptions and model specifications. We assume the managers cannot divert cash flows (i.e., $\theta = 0$), but they derive non-pecuniary payoffs. Specifically, the payoffs of the stage game are presented below.

Payoffs	Cooperate (C)	Defect (N)
Cooperate (C)	$\pi^C + b^C$, $\pi^C + b^C$	$\tilde{\pi}^C + \tilde{b}^C$, $\tilde{\pi}^N + \tilde{b}^N$
Defect (N)	$\tilde{\pi}^N + \tilde{b}^N$, $\tilde{\pi}^C + \tilde{b}^C$	$\pi^N + b^N$, $\pi^N + b^N$

Monetary payoffs are denoted by $\pi \in \{\tilde{\pi}^C, \pi^N, \pi^C, \tilde{\pi}^N\}$ and non-pecuniary payoffs are denoted by $b \in \{\tilde{b}^C, b^N, b^C, \tilde{b}^N\}$. The owners only value monetary payoffs, whereas the managers value monetary and non-pecuniary payoffs. There are several interpretations. First, higher cash flows might allow managers to consume more perks (ego, career concerns): $\tilde{b}^C = b\tilde{\pi}^C$, $b^N = b\pi^N$, $b^C = b\pi^C$, and $\tilde{b}^N = b\tilde{\pi}^N$ (i.e., $b \geq 0$ captures the strength of the non-pecuniary incentives). Second, the manager may have to exert effort to increase the firm's cash flows above that of the competitor: $\tilde{b}^C = \tilde{b}^N = 0$ and $b^N = \tilde{b}^N = -e$ (where $e > 0$). The presence of non-pecuniary benefits implies that the objectives of owners and managers are not always perfectly aligned. We assume

$$\tilde{\pi}^N + \tilde{b}^N > \pi^C + b^C > \pi^N + b^N > \tilde{\pi}^C + \tilde{b}^C. \tag{4}$$

The above holds when the stage game in monetary payoffs constitutes the Prisoner's dilemma, and private benefits are sufficiently small relative to cash flows. Under separate ownership, the players are manager 1, owner 1, manager 2, and owner 2. Under common ownership, the players are manager 1, manager 2, and the owner. The owner offers a contract specifying the manager's monetary payment for each period and each game's history. Manager i's period-t payoff is given by $r_{it} + b_{it}$, where $r_{it} \geq 0$ is the monetary payoff, and b_{it} is the private benefit (as before, we restrict monetary payments to be non-negative). Manager i's overall payoff is $\sum_{t=0}^{\infty} \delta^t (r_{it} + b_{it})$. The overall payoff of separate owner i is $\sum_{t=0}^{\infty} \delta^t (\pi_{it} - r_{it})$ (the overall payoff of the common owner is $\sum_{i=1}^{2} \sum_{t=0}^{\infty} \delta^t (\pi_{it} - r_{it})$). The owner of each firm and its manager can secretly renegotiate any previous contractual agreement. Thus, the equilibrium managerial compensation must be renegotiation-proof. Finally, we assume the owners have all the bargaining power and make take-it-or-leave-it offers to the managers.

A.1.1 One-shot interaction

Suppose the game is repeated once (or the discount factor δ is low). The main takeaway is that separate owners cannot sustain collusion, whereas common owners can sustain collusion in some cases - depending on the pattern of private benefits.

Collusive contract. The managers must be put on appropriate incentive schemes to ensure cooperation. Suppose each manager is paid $r^C(C) \geq 0$ for playing cooperatively and $r^C(N) \geq 0$ for playing uncooperatively, where

$$r^C(C) + b^C \geq r^C(N) + \tilde{b}^N$$

Then, the outcome in which both managers cooperate is consistent equilibrium.[21] Note that the cheapest way for the owners to ensure cooperation is by setting $r^C(N) = 0$ and $r^C(C) = r^C = \max\left\{\tilde{b}^N - b^C, 0\right\}$. The payoff to each manager is $r^C + b^C$ and the payoff to each owner is $\pi^C - r^C$ (a common owner gets $2(\pi^C - r^C)$).

Separate owners. Suppose all managers are put on the collusive contract described above and consider the following deviation: manager i's is paid $\tilde{r}^N$ for choosing N and zero for choosing C, where $\tilde{r}^N = r^C + b^C - \tilde{b}^N$. The manager's payoff remains the same, whereas the owner's payoff is strictly higher (since $\tilde{\pi}^N + \tilde{b}^N > \pi^C + b^C$ by (4)). As a result, the collusive incentive scheme is not renegotiation-proof under separate ownership leading to the unraveling of cooperation. The unique equilibrium under separate ownership is that both firms are behaving uncooperatively. Specifically, each manager is put on the contract $r^N(C) = 0$ and $r^N(C) = r^N = \max\left\{\tilde{b}^C - b^N, 0\right\}$ implying that in equilibrium the firms do not cooperate. Moreover, the non-cooperative contact is renegotiation-proof.[22]

Common owner. The common owner has two options: put both managers on the collusive contract r^C and get payoff $2(\pi^C - r^C)$ or put both managers on the non-collusive contract r^N and get payoff $2(\pi^N - r^N)$. The common owner induces the managers to cooperate whenever the gain from cooperation exceeds the collusion bonus $\pi^C - \pi^N > r^C - r^N$ (i.e., collusion is self-financing). Substituting for r^C and r^N into the last expression yields

$$\pi^C - \pi^N > \max\left\{\tilde{b}^N - b^C, 0\right\} - \max\left\{\tilde{b}^C - b^N, 0\right\}. \tag{5}$$

The common owner promotes anti-competitive behavior whenever the manager's private benefits are sufficiently small relative to the monetary gain from collusion (irrespective of the pattern of

[21] Note that non-cooperation is also an equilibrium if $r^C < b^N - \tilde{b}^C$. In such cases, one can impose the additional condition $r^C \geq b^N - \tilde{b}^C$ implying that cooperation becomes a weakly dominant strategy for the managers (a firm of robust contracting). For simplicity, we assume the managers coordinate on the collusive equilibrium whenever it exists and abstract from such robust contracts.

[22] Note: the contract $\tilde{r}^C(C) = \max\left\{b^N - \tilde{b}^C, 0\right\}$ and $\tilde{r}^C(N) = 0$ induces the manager to play uncooperatively, but also implies that the owner's payoff is strictly lower (since $\pi^N + b^N > \tilde{\pi}^C + \tilde{b}^C$ by (4)).

private benefits). It is useful to consider two special but important cases with different implications about the common owner's incentive to promote anti-competitive behavior.

Perks: Suppose the managers' private benefits are proportional to the firm's cash flows (i.e., higher cash flows allow managers to consume more perks): $\tilde{b}^C = b\tilde{\pi}^C$, $b^N = b\pi^N$, $b^C = b\pi^C$, and $\tilde{b}^N = b\tilde{\pi}^N$. The collusive contract is given by $r^C = b\left(\tilde{\pi}^N - \pi^C\right)$ with the bonus for collusion increasing in b. The no-collusive contract is given by $r^N = 0$. The common owner promotes collusion if and only if

$$b \leq \frac{\pi^C - \pi^N}{\tilde{\pi}^N - \pi^C} \equiv b_{max}.$$

That is if the miss-alignment of objectives between owners and managers is not too high. More generally, denote by $\overline{u}$ the manager's outside option. The collusive contract is given by a fixed wage $w = \overline{u}$ plus a collusion bonus $\triangle_C = \max\left\{b\left(\tilde{\pi}^N - \pi^C\right) - \overline{u}, 0\right\}$ whereas the no-collusive contract is given by a fixed wage $w = \overline{u}$. The common owner promotes collusion if the monetary gain $\pi^C - \pi^N$ exceeds the collusion bonus $\triangle_C$ (that is, if b is sufficiently small).

Quiet life: Suppose increasing firm's profits require the manager to exert more effort (i.e., working longer hours): $\tilde{b}^C = \tilde{b}^N = 0$ and $b^N = \tilde{b}^N = -e$ (where $e > 0$). In this case, putting both managers on a fixed wage w (equal to their outside option) ensures cooperation. In contrast, the non-collusive contract is given by a fixed wage w plus a bonus e to behave uncooperatively. The reason is that defection requires effort, which the manager is unwilling to undertake unless he gets a bonus for it (the managers prefer the "quiet life"). Finally, the common owner always selects the collusive outcome since $r^C = w + e > r^N = w$.

Summary. The managers can always be induced to cooperate through appropriate contractual arrangements. However, separate owners have no incentive to offer collusive contracts implying that a lack of cooperation characterizes the unique equilibrium of the stage game. On the other hand, a common owner puts the managers on a collusive contract whenever the monetary gain exceeds the managerial bonuses for collusion. Depending on the pattern of private benefits, the common owner promotes collusion in all cases (if the managers prefer the "quiet life") or only when the objectives of managers and owners are sufficiently aligned.

A.1.2 Repeated interaction

Suppose the game is repeated. The main takeaway is that collusion becomes easier for separate owners (since they can rely on trigger strategies) but not for a common owner (due to renegotiation incentives).

Trigger contracts. Repetition allows for trigger strategies. In particular, in period 0, all managers are given a collusive contract. In period $t \geq 1$ all managers are given the same collusive contract $r^C = \{r^C(C), r^C(N)\}$ if they all cooperated in the previous period. Otherwise, if one firm played uncooperatively, then all managers are given the no-collusive contract $r^N = \{r^N(C), r^N(N)\}$ in period t and all subsequent periods. Manager i's no defection condition is

$$\frac{r^C(C) + b^C}{1-\delta} \geq r^C(N) + \tilde{b}^N + \delta \frac{r^N(N) + b^C}{1-\delta}.$$

The left-hand side is the manager's overall payoff from cooperating (i.e., he gets $r^C(C) + b^C$ each period). The right-hand side is his overall payoff from defecting: he gets $r^C(N) + \tilde{b}^N$ in the period of deviation followed by $r^N(C) + b^C$ in all subsequent periods.

Separate owners. The profile of trigger contracts $T(r^C, r^N)$ constitutes (subgame perfect equilibrium) if no owner can gain from renegotiating. Specifically, manager i can be induced to play uncooperatively by the contract $\tilde{T}(\tilde{r}^N, r^N)$. The second component r^N is the same as the second component of $T(r^C, r^N)$. The first component $r^N = \{\tilde{r}^N(C), \tilde{r}^N(N)\}$ is given by $\tilde{r}^N(C) = 0$ and

$$\frac{r^C(C)}{1-\delta} = \tilde{r}^N(N) + \tilde{b}^N + \delta \frac{(r^N(N) + b^N)}{1-\delta}.$$

The contract $\tilde{T}(\tilde{r}^N, r^N)$ induces the manager to behave uncooperatively in period 0, and therefore, trigger reversion to non-cooperative play in all subsequent periods. Trigger contracts constitute equilibrium if such unilateral deviation is not profitable for the owner. That is, the owner's no defection condition is

$$\frac{\pi^C - r^C(C)}{1-\delta} \geq \tilde{\pi}^N - \tilde{r}^N(N) + \delta \frac{\pi^N - r^N(N)}{1-\delta}.$$

The left-hand side is the owner's overall payoff from offering the collusive contract to the manager. The right-hand side is his overall payoff from inducing the manager to play non-cooperatively (he gets $\tilde{\pi}^N - \tilde{r}^N(N)$ in period 0 and $\pi^N - r^N(N)$ in all subsequent periods). Substituting for $r^C(C)$ into the above and rearranging implies that the profile of trigger contrast is renegotiation-proof if and only if

$$\delta \geq \frac{(\tilde{\pi}^N + \tilde{b}^N) - (\pi^C + b^C)}{(\tilde{\pi}^N + \tilde{b}^N) - (\pi^N + b^N)} \equiv \delta_{min}. \tag{6}$$

Note that (4) implies $\delta_{min} \in (0, 1)$. Trigger contracts can be used to sustain cooperation whenever there is sufficiently little discounting. Two additional remarks are in order. First, the condition in (6) reduces to $\delta_{min} = (\tilde{\pi}^N - \pi^C)/(\tilde{\pi}^N - \pi^N)$ if the manager's private benefits are either constant or proportional to the firm's cash flows. Second, the separation of ownership and control does not reduce the players' ability to collude. Suppose the owner of each firm is also its manager (hence the private benefits accrue to the owner), and all firms are separately owned. One can easily show that the condition for collusion in the repeated game is still given by (6).

Common owner. A common owner will not stick to trigger strategies. As soon as one firm defects, the owner restarts the collusive agreement since failing to do so implies that the owner is not maximizing his continuation payoff. As a result, repetition would not enhance the common owner's capacity to sustain collusion, and the condition for cooperation continues to be given by 5.

In general, separate owners promote collusion if and only if 6 holds. On the other hand, a common owner promotes collusion if and only if 5 holds.[23] To drive sharper predictions, we consider special cases. First, suppose the private benefits are proportional to the firm's cash flows (i.e., the manager wants to consume *perks*). The table below provides a summary of the conditions allowing for collusion.

Perks	$b \leq \frac{\pi^C - \pi^N}{\tilde{\pi}^N - \pi^C}$	$b > \frac{\pi^C - \pi^N}{\tilde{\pi}^N - \pi^C}$
$\delta < \frac{\tilde{\pi}^N - \pi^C}{\tilde{\pi}^N - \pi^N}$	Common	None
$\delta \geq \frac{\tilde{\pi}^N - \pi^C}{\tilde{\pi}^N - \pi^N}$	Common; Separate	Separate

A common owner will promote collusion (independent of discounting δ) if the objectives of management and ownership are sufficiently aligned (b small enough). Separate owners, in contrast, would promote collusion if there is sufficiently little discounting - independent of how (miss) aligned the objectives of owners and managers might be. Second, suppose the managers prefer a quiet life.

Quiet life	
$\delta < \frac{\tilde{\pi}^N - \pi^C - e}{\tilde{\pi}^N - \pi^N}$	Common
$\delta \geq \frac{\tilde{\pi}^N - \pi^C - e}{\tilde{\pi}^N - \pi^N}$	Common; Separate

A common owner always promotes collusive behavior, whereas separate owners promote collusion only when there is sufficiently little discounting. Higher values of e (i.e., effort becomes costlier for the managers) implies a lower cutoff value for δ.

A.2 Additional figures

[23] Strictly speaking, the condition in 6 guarantees the existence of the collusive equilibrium. However, the firms might still coordinate on non-cooperative play (i.e., repetition of the uncooperative outcome of the one-shot game).

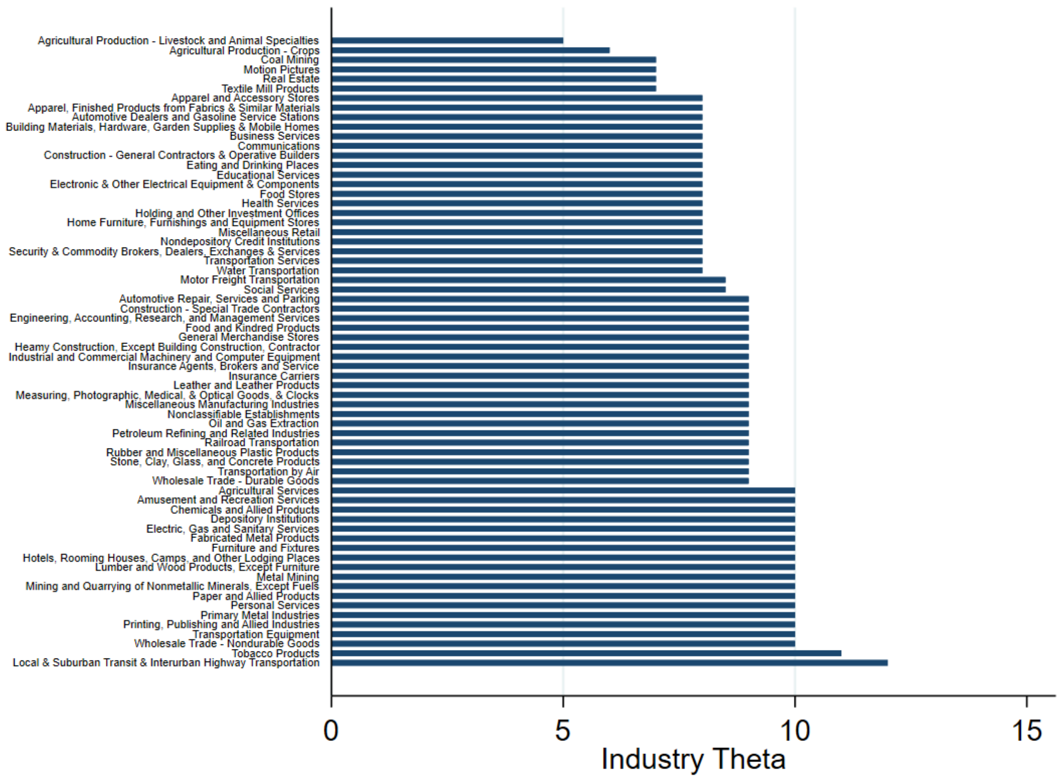

Figure A1: Industry median of the Gompers et al. (2003) Index, θ, for two digit SIC industries

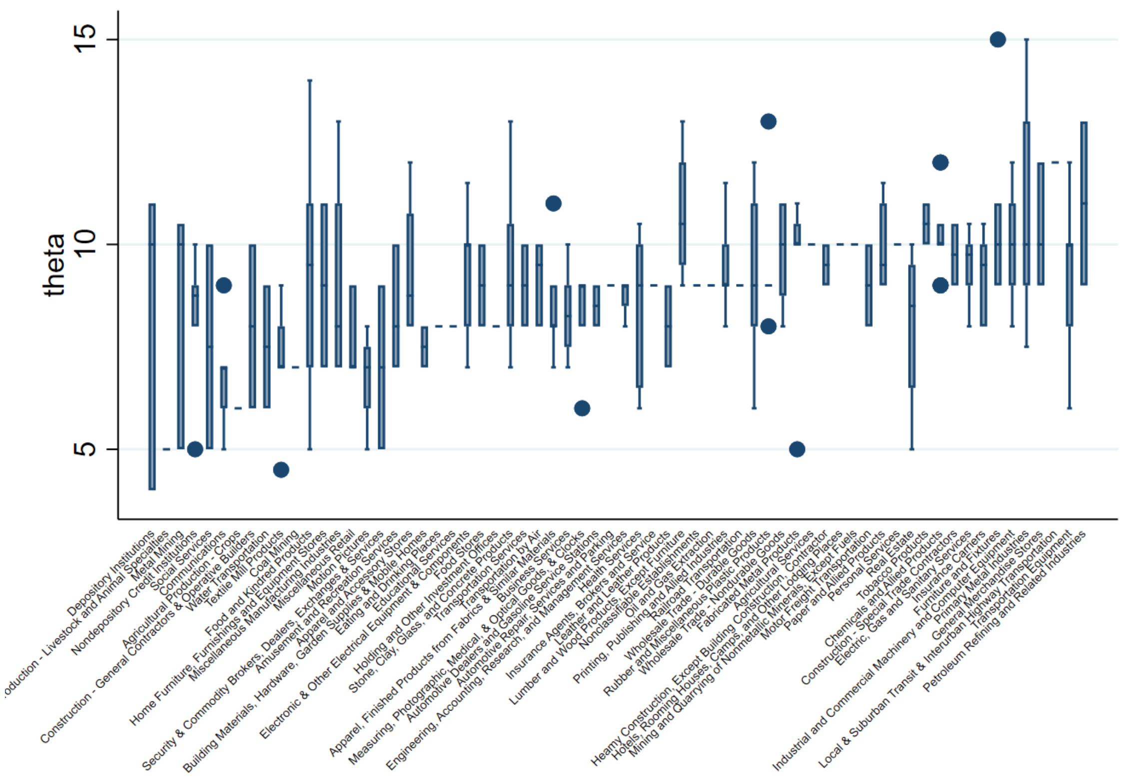

Figure A2: Distribution of the industry median of the Gompers et al. (2003) Index, θ, across three digit SIC industries for two digit industries.

A.3 Additional tables

Table A1: Translation of Industries from Grout and Sonderegger (2005) Table

Grout and Sonderegger (2005) Description & Cartel probability		SIC3	Description
Building of complete constructions or parts thereof; civil engineering	0.89	150	GENERAL BUILDING CONTRACTORS
Telecommunications	0.84	480	COMMUNICATIONS
Activities of other transport agencies	0.80	478	Miscellaneous Transportation Services
Manufacture of cement, lime and plaster	0.77	324 327	Cement, Hydraulic Concrete, Gypsum, and Plaster Products
Scheduled air transport	0.73	451	Air Transportation, Scheduled
Manufacture of basic chemicals	0.72	281	Industrial Inorganic Chemicals
Manufacture of pharmaceuticals, medicinal chemicals and botanical products	0.71	283	Drugs
Manufacture of motor vehicles	0.68	371	Motor Vehicles and Equipment
Software consultancy and supply	0.68	737	Computer and Data Processing Services
Manufacture of aircraft and spacecraft	0.65	376 372	Guided Missiles, Space Vehicles, Parts Aircraft and Parts
Manufacture of grain mill products, starches and starch products	0.61	204	Grain Mill Products
Legal, accounting, bookkeeping and auditing activities; tax consultancy; market research and public opinion polling; business and management consultancy	0.55	872	Accounting, Auditing and Bookkeeping
Manufacture of other food products	0.52	209	Miscellaneous Food and Kindred Products
Cargo handling and storage	0.50	422	Public Warehousing and Storage
Activities of travel agencies and tour operators; tourist assistance activities	0.46	472	Arrangement of Passenger Transportation
Publishing	0.44	270	PRINTING AND PUBLISHING
Manufacture of railway and tramway locomotives and rolling stock	0.44	374	Railroad Equipment
Other land transport	0.43		
Manufacture of tubes	0.41	301	Tires and Inner Tubes
Recycling of metal waste and scrap	0.40		
Manufacture of articles of paper and paperboard	0.40	260	PAPER AND ALLIED PRODUCTS
Manufacture of basic iron and steel and of ferroalloys	0.39	330	PRIMARY METAL INDUSTRIES
Manufacture of weapons and ammunition	0.39	348	Ordnance and Accessories, NEC
Manufacture of beverages	0.39	208	Beverages
Processing and preserving of fruit and vegetables	0.38	203	Preserved Fruits and Vegetables
Manufacture of motorcycles and bicycles	0.38	375	Motorcycles, Bicycles and Parts
Quarrying of sand and clay	0.37	145 144	Clay, Ceramic and Refractory Minerals Sand and Gravel
Building installation	0.36	170	SPECIAL TRADE CONTRACTORS
Sea and coastal water transport	0.35	440	WATER TRANSPORTATION
Non-scheduled air transport	0.34	452	Air Transportation, Nonscheduled

Table A2: Industry Profitability

Top Panel: δ	DV: Industry Price-Cost Margin					DV: Industry Markup				
	Density	PCF	PCS	MHHIΔ	C	Density	PCF	PCS	MHHIΔ	C
CO x δ_L (+)	−0.00	0.01	0.00	0.03	0.02	0.02	0.03*	0.04**	0.07**	0.05**
	(0.01)	(0.02)	(0.01)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
CO x δ_H (-)	−0.06**	−0.04	−0.04*	−0.05	−0.09**	−0.06	−0.02	−0.04	0.05	−0.05
	(0.02)	(0.03)	(0.03)	(0.05)	(0.04)	(0.03)	(0.04)	(0.03)	(0.06)	(0.07)
R^2	0.72	0.72	0.72	0.72	0.72	0.73	0.73	0.73	0.73	0.73
Observations	5572	5572	5572	5572	5572	5572	5572	5572	5572	5572
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bottom Panel: θ	DV: Industry Price-Cost Margin					DV: Industry Markup				
	Density	PCF	PCS	MHHIΔ	C	Density	PCF	PCS	MHHIΔ	C
CO x θ_H (-)	−0.03**	−0.02	−0.02*	−0.02	−0.04*	−0.00	0.02	0.01	0.08**	0.03
	(0.01)	(0.02)	(0.01)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
CO x θ_L (+)	0.01	0.04*	0.02	0.07	0.05*	0.01	0.04	0.04	0.05	0.03
	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)	(0.03)	(0.03)	(0.02)	(0.05)	(0.04)
R^2	0.72	0.72	0.72	0.72	0.72	0.73	0.73	0.73	0.73	0.73
Observations	5572	5572	5572	5572	5572	5572	5572	5572	5572	5572
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Panel regressions of annual industry price-cost-margin and industry markup on five different measures of common ownerhship interacted with indicators for δ_L, δ_H and θ_L, θ_H. (+) indicates a positive sign predicted by our model, (-) a negative sign, and (.) no effect. All dependent variables are lagged. Control variables: log assets, leverage, capital intensity, r&d intensity, indicator for only missing r&d expenditures, sales growth, HH-index, the inverse of the number of firms. Data are from US public firms 1988-2012 aggregated to the three-digit SIC industry level. Robust standard errors clustered at the SIC three-digit level in parentheses.

Table A3: CEO Compensation

	DV: Log(Compensation/Assets)				
	Density	PCF	PCS	MHHIΔ	C
CO x θ_H (-)	−0.02	−0.14	0.04	−0.36	−0.25
	(0.14)	(0.19)	(0.16)	(0.30)	(0.23)
CO x θ_L (+)	0.30	0.40*	0.43**	−0.06	0.52**
	(0.19)	(0.22)	(0.18)	(0.42)	(0.25)
Year FE	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓
R^2	0.63	0.63	0.63	0.63	0.63
Observations	4354	4354	4354	4354	4354

	DV: Log(Compensation/Market Value)				
	Density	PCF	PCS	MHHIΔ	C
CO x θ_H (-)	0.04	−0.08	0.11	−0.55**	−0.18
	(0.13)	(0.15)	(0.15)	(0.26)	(0.24)
CO x θ_L (+)	0.42***	0.83***	0.45***	−0.11	0.20
	(0.14)	(0.22)	(0.17)	(0.44)	(0.29)
Year FE	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓
R^2	0.58	0.58	0.58	0.58	0.58
Observations	4270	4270	4270	4270	4270

Panel regressions of annual total CEO compensation on five different measures of common ownerhship interacted with indicators for θ_L, θ_H. (+) indicates a positive sign predicted by our model, (-) a negative sign, and (.) no effect. All dependent variables are lagged. Control variables: log assets, leverage, capital intensity, r&d intensity, indicator for only missing r&d expenditures, sales growth, HH-index, the inverse of the number of firms. Data are from US public firms 1988-2012 aggregated to the three-digit SIC industry level. Robust standard errors clustered at the SIC three-digit level in parentheses.