# Common Ownership, Competition, and Top Management Incentives

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**Abstract**

We show theoretically and empirically that executives are paid less for their own firm's performance and more for their rivals' performance if an industry's firms are more commonly owned by the same set of investors. Higher common ownership also leads to higher unconditional total pay. We exploit quasi-exogenous variation in common ownership from a mutual fund trading scandal to support a causal interpretation. These findings challenge conventional assumptions in the corporate finance literature about the objective function of the firm.

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# I Introduction

The level and structure of top management pay has long been the subject of public critique, most recently by presidential candidates from both major political parties. In tandem with this public attention, a large academic literature has examined the issue, focusing primarily on unresolved agency problems as determinants of the structure executive pay packages.[1]

In contrast to the academic literature's focus, the public debate has recently centered on the role of firms' most powerful shareholders in bringing about, or at least condoning, what some perceive as "excessive" compensation. In particular, a small set of very large mutual fund companies have been challenged for systematically voting "yes" on compensation packages that guarantee a high level of pay, but are only weakly related to the (relative) performance of the firm a given manager runs.[2] High and performance-insensitive pay packages defy both common sense and established economic theory on optimal incentive provision. Why, then, do the largest and most powerful shareholders of most firms approve them?

This paper provides an explanation based on the combination of common ownership of firms by an overlapping set of investors and strategic product market competition. Widely diversified asset managers such as BlackRock and Vanguard earn money by charging their investors a fixed percentage of total assets under management. They therefore aim to maximize the value of their entire stock portfolio, rather than the performance of individual firms within that portfolio. Because fierce competition between portfolio firms reduces the value of the entire portfolio, it is in the asset managers' interest to structure executive pay in such a way that managers have weakened incentives to compete aggressively against their industry rivals. In short, high levels of common ownership rationalize performance-insensitive pay.

Crucial for identification, our explanation also generates testable predictions about the cross-sectional variation in pay-performance sensitivities and the level of pay: increasing common own-

[1] See, e.g., Bertrand and Mullainathan (2000, 2001a); Bebchuk et al. (2002); Bebchuk and Fried (2003, 2006).

[2] See Melby (2016). BlackRock, Vanguard, and Fidelity approve proposed pay packages at least 96% of the time (Melby and Ritcey, 2016).

ership concentration across industries or within industries over time should lead to reduced pay-performance sensitivity and less relative performance evaluation. Moreover, because less relative performance evaluation makes compensation packages riskier, more common ownership should also lead to higher unconditional pay. Our empirical results support these predictions. We conclude that the fact that broadly diversified investors endorse high, performance-insensitive compensation packages is easy to understand once one takes their (anticompetitive) economic interests into account.

Performance-insensitive compensation contracts are indeed more likely to be the result of strategic considerations by common owners rather than inattention or lack of power by large asset management firms. As measured by their own assertions, almost half of the hundreds of engagement meetings conducted every year feature discussions about executive compensation (Melby, 2016). In addition, the leaders of BlackRock (BLK) – the largest shareholder of about one fifth of all American corporations (Davis, 2013) – also claim to be empowered to influence firm behavior, even far beyond pay structure.[3] To bring about desired changes, “being able to talk to boards” in private engagement meetings is large asset managers’ “most important tool,” and more powerful than voting alone (BlackRock, 2015; Booraem, 2014). Indeed, “engagement is the carrot, voting is the stick” (BlackRock, 2016). In other words, BlackRock will “only vote against management when direct engagement has failed” (ibd). Judging from the voting patterns on pay, the large shareholders believe that the carrot is effective.[4]

Engagement meetings not only feature discussions about executive pay, but also about product market competition. Common owners explicitly advise firms on pricing decisions. For example, Chen (2016) reports that a group of seven major funds recently called a private meeting with top biotech and pharma executives in which “representatives, including those from Fidelity In-

[3]For example, BLK’s CEO and Chairman Larry Fink says “We can tell a company to fire 5,000 employees tomorrow” (Rolnik, 2016). Reuters headlines tell a similar story, e.g., “When BlackRock calls, CEOs listen and do deals” (Hunnicutt, 2016). Etc.

[4]Magnifying their already large individual power, large asset managers moreover appear to coordinate many corporate governance activities, including those regarding compensation (Foley and McLannahan, 2016; Foley, 2016). The potential of coordination among BlackRock, Vanguard, and State Street is particularly potent given that their combined power makes them the largest shareholder of 88% of all S&P 500 firms (Fichtner et al., 2016).

vestments, T. Rowe Price Group Inc. and Wellington Management Co., exhorted drug industry executives and lobbyists to do a better job defending their pricing" amid political and public pressure to do the opposite, and "encouraged them to investigate innovative pricing models." Schlangenstein (2016) reports that a common owner of six US airlines explicitly demanded that Southwest Airlines (SWA) "boost their fares but also cut capacity" – a move against what SWA's managers believe to be in SWA's best interest; see also Levine (2016).

Given common shareholders' attention to executive pay and their apparent power to affect it, it has puzzled observers why the shareholders "wield [their] outsized stick like a wet noodle" (Morgenson, 2016) and rubber-stamp, if not encourage, compensation contracts that contradict fundamental predictions of established incentive theory. This paper provides a simple explanation based on a generalization of the standard model of incentive provision along the dimension of firms' ownership structure, along with empirical support for its more subtle predictions. This evidence is corroborated by anecdotal evidence on common owners' conscious attempts to influence pay structures and product market strategy.

The theoretical part of this paper generalizes the standard model of optimal incentive provision in principal-agent problems (e.g., Holmstrom (1979)). Standard models typically assume that shareholders unanimously want the manager to maximize the firm's own value. The assumption of own-firm profit maximization leads to the prediction of relative performance evaluation (RPE): the optimal way to incentivize a risk-averse manager to exert effort is to pay her more if the firm she runs performs better. At the same time, shareholders should filter out shocks that affect the entire industry and that the manager is unable to influence (Holmstrom, 1982) to reduce the total compensation necessary to match the risk-averse manager's reservation wage.

The clarity of this theoretical prediction contrasts with mixed empirical support which we discuss in more detail in Section II. In short, RPE is used in incentive contracts – indeed, even stock and option grants (which make up almost half of total pay) are often indexed. However, all told RPE is used in less than half of all contracts (Gong et al., 2011; De Angelis and Grinstein, 2016; Bettis et al., 2014). We are interested in whether common ownership helps explain the variation in the use of RPE. Specifically, we measure how common ownership concentration relates to the actual pay managers receive, and therefore how the RPE provisions affect managers' economic incentives.

To approach that question, we depart from the standard model, first, by allowing for the possibility that firms have some market power and are thus engaged in strategic interaction with their industry rivals. As a result, managers can influence their own firm's and their competitors' profits by the choice of their competitive strategy. As a second departure from the standard model, we assume that shareholders can hold shares in more than one firm in the industry. This assumption gives shareholders a reason to incentivize managers to not only maximize their own firm's profits in isolation, but to consider the firm's rivals' profits as well.

Our model predicts that RPE is optimal when each firm is owned by a different investor or each firm's strategic decision does not influence its competitors. However, if the most powerful shareholders of a firm also own stakes in the firm's competitors, shareholders want to incentivize managers to compete less aggressively (e.g., avoid price wars with the goal to increase market share). Instead, shareholders then reward top managers more for industry profits, irrespective of whether the profits come from the firms the managers actually run or from the firms against which they compete. Hence, in equilibrium, common ownership decreases the optimal incentive slope on own-firm performance and increases the optimal managerial reward for rival firms' performance. Importantly, and in stark contrast to extant work on top management incentives under imperfect competition, these results obtain independent of the mode of competition (Cournot or Bertrand).

We further show that common ownership leads to higher unconditional CEO compensation levels. In our simple model, the reason is that common ownership implies it is better *not* to benchmark pay packages against aggregate industry fluctuations, thus rendering managerial pay packages riskier than they would be if common industry shocks were filtered out. Risk-averse managers with a given outside option therefore demand higher baseline pay as compensation for the additional risk.

On the empirical side, we begin by documenting the extent to which the same set of diversified investors own natural competitors in U.S. industries. Specifically, one novel contribution of our paper is to document both how many firms and what fraction of firms have a particular common investor among the top shareholders. For example, today both BlackRock and Vanguard are among the top five shareholders of almost 70 percent of the largest 2,000 publicly traded firms in the US; twenty years ago that number was zero percent for both firms. As a result of such common ownership links, ownership-adjusted levels of market concentration are frequently twice as large as suggested by traditional concentration indexes that counterfactually assume completely separate ownership.

We then test the model's qualitative predictions.[5] First, we run panel regressions of total executive pay (including the value of stock and option grants) on the firm's performance, rival firms' performance, measures of market concentration and common ownership of the industry, and interactions of profit, concentration, and common ownership variables. We find that higher levels of common ownership are associated with (i) lower pay-for-own-performance sensitivity, (ii) higher pay-for-rival-performance sensitivity, and (iii) higher unconditional CEO pay. These relationships are identified from variation in the time series and in the cross section: managers in more commonly owned industries receive more pay for industry performance and less for their own firm's performance, and when a given industry becomes more commonly owned, its managers receive less pay for own and more for their rivals' performance.

Importantly, these results are remarkably robust to various alternative industry definitions (Hoberg and Phillips, 2010, 2016). Moreover, we use an estimate of the managers' wealth stock that includes accumulated stock and options as the dependent variable rather than the flow of total pay (Edmans et al., 2009) to confirm that the *wealth*-performance sensitivity also decreases with common ownership. The results are also robust to the measure of common ownership density we use. In particular, we know the potential endogeneity of market shares is not driving the results, because similar results obtain with market-share-free measures of common ownership

[5]Our model serves to build intuition, and to clarify the difference in mechanics to the case of managerial incentives under imperfect competition but separate ownership studied by Aggarwal and Samwick (1999a) and Vrettos (2013). It is, however, not a model intended for structural empirical analysis.

concentration.

To strengthen a causal interpretation of the link between common ownership concentration and top management incentives that discourage aggressive competition, we use plausibly exogenous variation in ownership caused by a mutual fund trading scandal in 2003, which affected funds that jointly held 25% of total mutual fund assets.[6] The results corroborate the findings from the panel regressions: executives are given weaker incentives to compete aggressively when their industry is more commonly owned.

# II Related Literature

The existing literature has recognized links between imperfect competition and optimal incentive contracts, and between common ownership and imperfect competition. This paper completes the triangle between the three concepts by establishing a link between common ownership and optimal incentive contracts. That link is non-trivial when firms strategically interact due to imperfect competition. Thus, all three elements interact.

The most closely related paper is Aggarwal and Samwick (1999a) (AS) who examine theoretically and empirically how managerial compensation is related to product differentiation. In contrast, we are interested in how common ownership concentration across industries and time affects the structure of managerial incentives, controlling for the effect AS propose. More specifically, AS show theoretically that the sign of the relation between product differentiation and the use of RPE depends on whether firms compete à la Bertrand or Cournot, and they show empirically how incentive slopes depend on industry structure, as measured by the $HHI$.[7] In con-

[6]Ownership structures are endogenously determined in general (Bolton et al., 1998), can depend on the stock price (Bolton et al., 2006), and could be endogenous to how product market competition relates to the features of managerial contracts we study. Using quasi-exogenous variation of ownership mitigates concerns that such endogeneities drive our main results.

[7]AS follow theoretical precursors on contracting with RPE by Holmstrom (1982) and Diamond and Verrechia (1982) as well as papers that examine the relation between incentive pay and product market competition by Fershtman and Judd (1987), Sklivas (1987), Fumas (1992), and Meyer and Vickers (1997). Other theoretical papers studying the interaction between managerial incentives and product market competition include Hart (1983), Scharfstein (1988), Hermalin (1992), Schmidt (1997), Raith (2003), Vives (2004), and Baggs and de Bettignies

trast, we measure how incentive slopes relate to common ownership concentration, as measured by $MHHID$ (O'Brien and Salop (2000)'s "$MHHI$ delta"), controlling for the effect of $HHI$. Thus, total market concentration is $MHHI = HHI + MHHID$.[8] In terms of results, we show both theoretically and empirically that the effect of common ownership concentration on the use of RPE is unambiguously negative, irrespective of the mode of competition.

The theoretical idea that shareholder diversification leads to managerial incentive problems to which contracts need to be adapted dates back to at least Arrow (1962).[9] Gordon (1990) is the first to study (linear) RPE contracts under common ownership.[10] In Gordon's model, common ownership is modeled by exogenous positive effort spillovers on other firms in the industry. In contrast, we explicitly model the product market interaction between these firms. Doing so allows us to analyze product market interactions for both Cournot and Bertrand competition, which reveals the unambiguous prediction that common ownership reduces the optimal use of RPE.

Relatedly, our paper also contributes to the large empirical and theoretical literature that examines the extent and variation in the use of RPE. Significant contributions to this literature include Antle and Smith (1986), Gibbons and Murphy (1990), Barro and Barro (1990), Janakiraman et al. (1992), Aggarwal and Samwick (1999b), Bertrand and Mullainathan (2001b), Garvey and Milbourn (2006), and Jenter and Kanaan (2015) as well as the surveys by Murphy (1999), Frydman and Jenter (2010), and Edmans and Gabaix (2016). Elhauge (2016) argues that the patterns discovered by this literature are most easily understood in the context of common ownership.

(2007) while Cunat and Guadalupe (2005, 2009) provide empirical evidence. Brander and Lewis (1986), Maksimovic (1988), Bolton and Scharfstein (1990), Scharfstein (1990), Chevalier (1995a,b), Phillips (1995), and Kovenock and Phillips (1997) examine the interplay of other financial contracts and product market competition.

[8] Another difference in methodologies is that in addition to cross-sectional variation as in AS, we also use time-series variation, as well as plausibly exogenous changes in ownership resulting from a trading scandal in 2003 for identification. The latter variation was exploited previously by Anton and Polk (2014). A more detailed description of the scandal is given by Zitzewitz (2006) and Zitzewitz (2009). Kisin (2011) uses the same shock for different purposes.

[9] "[A]ny individual stockholder can reduce his risk by buying only a small part of the stock and diversifying his portfolio to achieve his own preferred risk level. But then again the actual managers no longer receive the full reward of their decisions; the shifting of risks is again accompanied by a weakening of incentives to efficiency. Substitute motivations [...] such as executive compensation and profit sharing [...] may be found".

[10] Similar arguments have since been discussed in variations by Hansen and Lott (1996), Rubin (2006), and Kraus and Rubin (2006).

A closely related literature debates how (quantitatively) sensitive pay has to be to performance to effectively incentivize managers (Jensen and Murphy, 1990; Haubrich, 1994; Hall and Liebman, 1998).

Explanations for the absence or reduced importance of RPE include career concerns and implicit incentives (Meyer and Vickers, 1997; Garvey and Milbourn, 2003; Core and Guay, 2003), product market competition (Fumas, 1992; Joh, 1999; Aggarwal and Samwick, 1999a; Vrettos, 2013), aggregate shocks (Himmelberg and Hubbard, 2000), the incentive-reducing effects of option indexation (Dittmann et al., 2013), limited liability (Chaigneau et al., 2014), the absence of an appropriate comparison group (Albuquerque, 2014), outside opportunities (Oyer, 2004), and "keeping up with the Joneses" preferences (DeMarzo and Kaniel, 2016) as well as imprecise industry or peer classifications (Albuquerque, 2009; Gong et al., 2011; Jayaraman et al., 2015; Lewellen, 2015). Regarding the latter literature, it is noteworthy that the "common ownership" effect we document is present both when SIC or Hoberg-Phillips industry classifications are used to define competitors (Hoberg and Phillips, 2010, 2016) and even when we use the most conservative measures from the perspective of finding support for our explanation. Moreover, the variation in common ownership provides a new rationale for why the use of RPE differs across industries and time.

By showing both a positive relation of CEO pay with common ownership and an increase of common ownership over time, the present paper relates to the continuing academic and public debate on the causes of the increase in CEO pay over the past decades (Bebchuk and Grinstein, 2005; Gabaix and Landier, 2008).

Next, our paper relates to a recent literature that investigates the causes and consequences of "common ownership" of firms. In particular, Azar et al. (2015, 2016) argue that common ownership causes higher product prices in the airline and banking industries, respectively. The present paper provides a first answer to the question of how anticompetitive shareholder incentives resulting from common ownership are translated into the anticompetitive behavior of firms. Our analysis shows that managerial incentives are, at least to some extent, aligned with common shareholders' anticompetitive incentives. It also supports the view that anticompetitive effects caused by common ownership can obtain without "collusion," that is, without direct or indirect coordination between firms. This insight informs an active debate in the legal literature over whether the findings documented by Azar et al. (2015, 2016) constitute a violation of antitrust laws, and which tools are necessary to enforce them (Elhauge, 2016; Baker, 2016).[11]

Finally, the summary statistics on common ownership concentration (MHHID), the main explanatory variable in our study, are a significant contribution to the fast-growing literature on common ownership. Previous papers have provided measures of ownership for various markets within an industry, but none has calculated common ownership concentration across several industries and across time. Moreover, our analysis of the number and fraction of common ownership links created by particular investors in various industries complements and refines an analysis by Azar (2012, 2016) who reports the change over time in the likelihood that two randomly selected S&P 1500 firms in the same industry have an overlapping shareholder of a certain size.

# III Model and Hypothesis Development

## A Setup

The following stylized model of product market competition and managerial contracts analyzes the role of common ownership. Our model builds on the setup of Aggarwal and Samwick (1999a). The main difference is that we extend their model to allow for common ownership.

[11]A significant fraction of common ownership stems from ownership by investors with predominantly passive investment strategies. So-called "passive" investors are known to influence corporate governance in general terms (Appel et al., 2016). Schmalz (2015), Azar et al. (2015), and Schmalz (2016) go one level deeper and discuss the potential roles of shareholder engagement, hedge fund activism, and shareholder voting in implementing outcomes consistent with shareholders' anticompetitive incentives. Brav et al. (2008) and Keusch (2016) provide empirical support for the prediction that activist hedge funds reduce CEO pay and implement steeper pay-for-performance contracts. Activists tend to not be common owners of firms within the same industry.

## A1 Product Market Competition

Two firms are labeled 1 and 2. The model has two stages. At stage 1, the owners (she) of the firms write contracts with the managers (he). At stage 2, the managers engage in differentiated Cournot (Bertrand) competition. We assume that a manager's action choice at stage 2 is noncontractible. However, profits are contractible. The two firms face symmetric inverse demand functions given by

$$P_i(q_i, q_j) = A - bq_i - aq_j, \tag{1}$$

where $i, j \in 1, 2$ and $b > a > 0$. Thus, the manager's action choice has a greater impact on the demand for his own product than does his rival's action.[12]

The firms have symmetric marginal costs $c$. The profits of firm $i$ are therefore given by

$$\pi_i = q_i(A - bq_i - aq_j - c). \tag{2}$$

## A2 Managers

Following the literature, and in particular Aggarwal and Samwick (1999a), we assume that the following linear contract is offered to the manager of firm $i$:

$$w_i = k_i + \alpha_i \pi_i + \beta_i \pi_j. \tag{3}$$

In this setup, $\alpha_i$ is the incentive slope on own firm profits, $\beta_i$ is the incentive slope on rival firm profits (RPE), and $k_i$ is the fixed payment used to satisfy the individual rationality constraint which is pinned down by the manager's outside option $w_i^{'}$. Two risk-neutral managers, 1 and 2, set the quantity (price) for their respective firm in accordance with the incentives given by their

[12] Although we assume linear demands and two firms, the results of our model generalize to nonlinear demand functions and industries with more than two firms.

contracts.

Thus, each manager $i$ sets quantity (price) to maximize one of the following two objective functions:

$$\max_{q_i} \alpha_i(q_i - c)(A - bq_i - aq_j) + \beta_i(q_j - c)(A - bq_j - aq_i) \tag{4}$$

$$\max_{p_i} \alpha_i(p_i - c)(B - dp_i + ep_j) + \beta_i(p_j - c)(A - dp_j + ep_i), \tag{5}$$

where the coefficients for Bertrand competition are

$$B = \frac{A}{b+a}, \quad d = \frac{b}{(b+a)(b-a)}, \quad e = \frac{a}{(b+a)(b-a)}. \tag{6}$$

The managers' reaction functions for Cournot (Bertrand) competition are given by

$$R_i'(q_j) = \frac{A-c}{2b} + \frac{aq_j(\alpha_i + \beta_i)}{2\alpha_i b} \tag{7}$$

$$R_i'(p_j) = \frac{B + dc + ep_j}{2b} + \frac{\beta_i e(p_j - c)}{2\alpha_i d}, \tag{8}$$

and hence the optimal quantity (price) choices are

$$q_i^* = \frac{\alpha_j(A-c)(\alpha_i a - 2\alpha_i b + \beta_i a)}{-4\alpha_j b^2 \alpha_i + \alpha_i a^2 \beta_j + \alpha_i a^2 \alpha_j + \beta_i a^2 \beta_j + \beta_i a^2 \alpha_j} \tag{9}$$

$$p_i^* = \frac{-\alpha_j B(\alpha_i a + 2d\alpha_i + \beta_i e) - \alpha_j dc(2d\alpha_i + \alpha_i e - \beta_i e) + e^2 c\beta_j(\alpha_i + \beta_i)}{-4\alpha_i d^2 \alpha_j + \alpha_i e^2 \alpha_j + \alpha_i e^2 \beta_j + \beta_i e^2 \alpha_j + \beta_i e^2 \beta_j}. \tag{10}$$

First, note that if $\beta_1 = \beta_2 = 0$, we obtain the standard differentiated Cournot (Bertrand) equilibrium for any $\alpha_i > 0$. This is because without any RPE each manager just maximizes his own firm's profits the way an undiversified owner-manager would. Second, for the manager's action choice, only the relative magnitude (or "compensation ratio") of $\alpha_i$ and $\beta_i$ matters because no effort incentive problem exists and the base pay $k_i$ perfectly offsets any profit-based payments. Thus, a continuum of optimal contracts exists for each firm's manager which is only pinned down by the ratio $\frac{\alpha_i}{\beta_i}$. In this model, RPE exists purely for strategic reasons. RPE produces no gain due to better signal extraction from correlated noise shocks because no hidden action problem and risk aversion exist. However, in subsection C, we extend our model to allow for RPE due to managerial risk aversion. Finally, $w_i$ is irrelevant in the maximization problem stated here because without risk aversion and a binding individual rationality constraint, no welfare loss results from imposing risk on the agent.

### A3 Owners

There are two owners, A and B. To simplify the exposition, we assume that they are symmetric such that A owns a share $x \geq 1/2$ of firm 1 and $1-x$ of firm 2 and B owns $1-x$ of firm 1 and $x$ of firm 2. Given the symmetric ownership shares $1-x$ measures the degree of common ownership in the industry. Each majority owner sets an incentive contract $(k_i, \alpha_i, \beta_i)$ for her manager $i$ such that it maximizes the profit shares of the owner at both firms.[13] The optimal incentive contract for manager $i$ should internalize the effect on profits of firm $j$ to the extent that the majority owner of firm $i$ also owns shares of firm $j$. Hence, the relevant maximization problem for the majority owner of firm $i$ is

$$\max_{k_i,\alpha_i,\beta_i} x(\pi_i - w_i) + (1-x)(\pi_j - w_j) \tag{11}$$

$$\text{subject to} \quad w_i \geq w_i^{'} \quad \text{and} \quad q_i^* \in \arg\max_{q_i} w_i \quad \text{or} \quad p_i^* \in \arg\max_{p_i} w_i. \tag{12}$$

## B Results

To build intuition, consider the extreme cases of completely separate ownership $(1-x=0)$ and equal ownership $(1-x=1/2)$.

[13]The assumption that the majority owner sets the terms of the incentive contract is made for expositional simplicity. However, even with "one share, one vote" majority voting the majority owner would be able to implement the same contract.

## B1 Separate Ownership $(1 - x = 0)$

Under completely separate ownership $(1 - x = 0)$, the equilibrium incentives under Cournot competition are

$$\beta_i^* = -\alpha_i^* \frac{a}{2b + a} < 0 \tag{13}$$

for any $\alpha_i^* > 0$, whereas under Bertrand competition, they are

$$\beta_i^* = \alpha_i^* \frac{e}{2d - e} > 0 \tag{14}$$

for any $\alpha_i^* > 0$ where $\beta_i^* < \alpha_i^*$ because $d > e$.

Thus, under completely separate ownership, owners optimally set managerial incentives in such a way that they punish (reward) the manager of their firm for the profits of the other firm. As noted above, this form of RPE is entirely the result of the owners' strategic product market considerations. As is common in models of industrial organization, these considerations lead to diametrically opposed results under Cournot and Bertrand competition.

The intuition is as follows. With strategic complements, the firms' reaction functions are upward-sloping, and hence a price increase by one firm is met by a price increase by the other firm. As a result, each owner prefers its manager not to compete too aggressively with the other firm, and the best way to induce this is by setting $\beta_i^* > 0$. This incentive scheme induces the manager to set high prices because lower prices would hurt the other firm's profits. On the other hand, with strategic substitutes, the situation is reversed and each owner optimally sets $\beta_i^* < 0$ to punish her manager for the profits earned by the other firm. It is also easy to show that compared to incentive contracts without RPE (i.e., $\beta_i = 0$), equilibrium profits are lower (higher) with RPE under Cournot (Bertrand) competition because of these strategic substitutes (complements).

### B2 Perfectly Common Ownership $(1 - x = 1/2)$

Under equal and thus perfectly common ownership $(1 - x = 1/2)$, the equilibrium incentives are

$$\beta_i^* = \alpha_i^* > 0 \tag{15}$$

for any $\alpha_i^* > 0$ under both Cournot and Bertrand competition. Thus, with perfectly common ownership, we obtain the same monopoly equilibrium for both forms of competition because in equilibrium, the owners will design managerial incentives that place equal weight on own and rival profits.

### B3 Statement of the Central Result

Comparing the incentive slope on profits of the rival firm $\beta_i^*$ in the two extreme cases of ownership, it is easy to see that $\beta_i^*$ increases under *both* forms of competition when moving from separate to perfectly common ownership. Under Bertrand competition, it increases from $\alpha_i^* \frac{e}{2d-e} < \alpha_i^*$ to $\alpha_i^*$, whereas under Cournot competition, it increases from $-\alpha_i^* \frac{a}{2b+a} < \alpha_i^*$ to $\alpha_i^*$. Thus, the sign of the change in $\beta_i^*$ is always positive, and hence we have an *unambiguous* prediction for how common ownership should change managerial incentives.[14] Our prediction also holds for all intermediate cases of ownership $(1/2 < x < 1)$. In particular, the optimal incentives as a function of product market conditions and ownership for a symmetric equilibrium are given by

$$\text{Cournot:} \quad \beta^* = \frac{-a + 2(a+b)x - \sqrt{a^2 + 4b^2x^2 + 4ab(-2+3x)}}{2a(1-x)}\alpha^* \tag{16}$$

$$\text{Bertrand:} \quad \beta^* = \frac{-e - 2(d-e)x + \sqrt{e^2 + 4ed(2-3x) + 4d^2x^2}}{2e(1-x)}\alpha^*. \tag{17}$$

The following proposition establishes our main theoretical result.

[14] Note, however, that the magnitude of this change in incentives is larger under Cournot than under Bertrand competition.

**Proposition 1.** *Under both forms of competition, the optimal inverse compensation ratio* $\frac{\beta^*}{\alpha^*}$ *is increasing in* $1-x$ *for* $1/2 \leq x \leq 1$.

The intuition for this result is straightforward. As $1-x$ increases, that is, as common ownership increases, each owner cares relatively more about the profits of the other firm in the industry. Thus, each owner would prefer softer competition between the two firms that she owns. As a result, she sets incentives for the manager of her majority-owned firm to induce less competitive strategic behavior. She does so by increasing $\beta_i$ or decreasing $\alpha_i$. Note further that the value of $x$ has no impact on the product market shares and the $HHI$ because the underlying cost and demand structures remain unchanged. However, common ownership changes with the value $x$ and it attains its maximum at $x = 1/2$. Accordingly, in our empirical tests, we will hold market shares constant and vary only the degree of common ownership.

Finally, it is important to emphasize that our result unambiguously holds independent of the form of competition which tends to be the exception in models of strategic product market interaction.[15] Regardless of whether the action variable has strategic substitutability or complementarity (i.e., the two firms are not completely separate monopolists, $a > 0$) common ownership always increases the inverse compensation ratio.

## C Model Extensions and Generalizations

Our baseline model abstracts from managerial risk aversion and moral hazard problems that potentially exist between the owners and managers. In doing so we follow the modeling choices adopted in Fershtman and Judd (1987), Sklivas (1987), and Aggarwal and Samwick (1999a). However, in the online appendix, we also present two additional closely related contracting models that incorporate costly managerial effort choice, risk aversion, and a common shock to firm profits.[16] Most importantly, in both models, our central prediction that common ownership increases

[15] For example, Aggarwal and Samwick (1999a) show that the predicted effect on executive compensation of their main variable of interest switches signs when competition changes from Cournot to Bertrand.

[16] All of our analysis is also robust to the idea that the manager of each firm derives private benefits from maximizing his own firm's profits. These private benefits could arise from managerial perks or career concerns.

the inverse compensation ratio $\frac{\beta^*}{\alpha^*}$ remains unchanged. Moreover, the two models generate two additional empirical predictions.

First, we study a multi-tasking model in the spirit of Holmstrom and Milgrom (1991) in which the manager of firm $i$ can enhance the profits of his own firm as well as influence (e.g., through investments) the profits of the rival firm. The model separately ties down the optimal levels of the incentive slopes $\alpha^*$ and $\beta^*$. In particular, it predicts that $\alpha^*$ is decreasing and $\beta^*$ is increasing in the degree of common ownership. (The baseline model predicts only the composite effect on the ratio of the incentive slopes while remaining silent about the separate components.) The following proposition states this claim more formally:

**Proposition 2.** *The optimal incentive slope on own profits $\alpha^*$ is decreasing and the optimal incentive slope on rival profits $\beta^*$ is increasing in $1 - x$ for $1/2 \leq x \leq 1$.*

*Proof.* See internet appendix. □

Second, in both the multi-tasking model as well as our baseline product market competition model (augmented by costly managerial effort, risk aversion, and a common shock), an increase in common ownership increases the level of base pay $k^*$.

**Proposition 3.** *The optimal base pay $k^*$ is increasing in $1 - x$ if the impact on rival-firm profits and managerial risk aversion are sufficiently high.*

*Proof.* See internet appendix. □

In other words, unconditional base pay increases as the degree of common ownership increases. The intuition is as follows. The owner trades off two conflicting aims of RPE: providing risk insurance from the common shock to the manager and incentivizing managerial choices that positively affect the rival firm. If the manager has no influence on the profits of the other firm (e.g., very high product differentiation and hence separate monopolies), then the second consideration is absent. Hence, it is always optimal for the owner to use strong RPE by setting $\beta^* = -\alpha^*$, thereby completely filtering out all the common noise in the firm's profits and providing perfect insurance to the manager. However, if the manager's actions also affect the rival firm, setting $\beta^* = -\alpha^*$ will no longer be optimal because such incentives would lead to excessively competitive behavior (e.g., price wars) on behalf of the manager, and thus lower aggregate profits. However, an incentive scheme where $\beta^* > -\alpha^*$ exposes the risk-averse manager to some aggregate risk. Given that the manager is risk-averse, meeting his outside option now requires paying a higher base wage. We now take these predictions to the data.

# IV Data

The model yields testable implications for the relationship between common ownership and the structure and level of top management pay. To test these predictions, we need data on executive compensation, performance, ownership, and a robust industry definition. In what follows, we first describe how common ownership is measured and then detail the data sources used to construct our variables.

## A Measuring Common Ownership Concentration

To identify the extent to which common ownership concentration in an industry affects managerial incentives we first need to define a measure of common ownership concentration. This endeavor is substantially more complicated in the empirical analysis than in theory, because there are typically more than two firms per industry and because different types of shareholders hold different portfolios. Fortunately, the existing literature provides a candidate measure of common ownership concentration that addresses these challenges.

We measure common ownership concentration with $MHHID$, proposed by O'Brien and Salop (2000) and previously implemented empirically by Azar et al. (2015). The approach assumes that firms maximize a weighted sum of the portfolio profits accruing to their shareholders. A special case is the maximization of the own firm's value; this case obtains when each shareholder has her entire wealth invested in one single firm. Formally, the objective function of firm $j$ is assumed to be

$$\max_{x_j} \Pi_j = \sum_{i=1}^{M} \gamma_{ij} \sum_{k=1}^{N} \beta_{ik} \pi_k, \tag{18}$$

where $\gamma_{ij}$ is the control share of firm $j$ held by owner $i$, and $\beta_{ij}$ is the ownership share of firm $j$ accruing to investor $i$. Note that this objective is proportional to the sum of the firm's own profits and a weighted average of the profits of the other firms in the industry, whereas the weights are determined by the extent to which the respective rivals are owned by the same shareholders that have control rights in firm $j$,

$$\pi_j + \sum_{k \neq j} \frac{\sum_i \gamma_{ij} \beta_{ik}}{\sum_i \gamma_{ij} \beta_{ij}} \pi_k. \tag{19}$$

Using this objective function in a Cournot model yields the prediction that industry markups are proportional to a modified $HHI$ index of market concentration, $MHHI$. Note that in the special case of completely separate ownership we have $MHHI = HHI$.

$$MHHI = HHI + \sum_j \sum_{k \neq j} s_j s_k \frac{\sum_i \gamma_{ij} \beta_{ik}}{\sum_i \gamma_{ij} \beta_{ij}} \tag{20}$$

where $s_j$ is the market share of firm $j$, and the final term on the right hand side is the common ownership concentration in the industry, which we abbreviate $MHHID$. Note that $MHHID$ closely corresponds to the objective function of the firm reflected in Equation (19). Therefore, the question how common ownership concentration (as measured by $MHHID$) relates to managerial incentives is potentially informative about the objective function of the firm.

# B Data Description

The model yields testable implications for how the structure of top management pay, and in particular RPE, varies with common ownership. RPE is typically implemented by granting a set of stocks and options with different strike prices and vesting periods that depend on performance of the company compared to the performance of peers. Those peers are chosen by the designers of the contract, and are supposed to be the closest and most important competitors of the company. Gong et al. (2011), Bettis et al. (2014), and De Angelis and Grinstein (2016) describe the variation in the prevalence of such features in compensation contracts. By contrast, our interest does not lie in whether or not such conditions are present in the contracts, but in their quantitative importance for the executives' effective economic incentives. The two are not the same. For example, firms may implement RPE in contracts pro forma, but only for a small fraction of total pay, making the provision less effective in influencing manager behavior. We therefore use data on the actual pay that managers receive, rather than on the contracts that govern the pay packages. To that end, the first data set we use for this study is ExecuComp.

**Executive Compensation.** ExecuComp provides annual panel compensation data for the top five executives of S&P1500 plus 500 additional public firms. The data includes details about compensation, tenure, and position. We use the flow of total compensation (TDC1) as our main measure of compensation for several reasons. First, Gong et al. (2011), Bettis et al. (2014), and De Angelis and Grinstein (2016) show that RPE is implemented through the granting stock and options awards that vest conditional on performance outcomes. TDC1 already incorporates the vesting conditions that have to be fulfilled in the future, by valuing stock and option awards at the grant-date fair value in accordance with SFAS 123R.[17] Specifically, total compensation (TDC1) includes salary, bonus, long-term incentive payouts, the grant-date fair value of stock and option awards, and other payouts. Summary statistics about pay level, standard deviation, and distribution are given in Table 1 Panel A. The average (median) yearly compensation of an executive in our sample is \$2.31m (\$1.36m) and average (median) tenure is 4.6 (3) years.

**Firm Performance.** Following Aggarwal and Samwick (1999a), we measure firm performance as the increase in the firm's market value (lagged market value multiplied by stock return), and rival performance as the value-weighted return of all firms in the industry excluding the firm in question, multiplied by the respective firm's last-period market value. This measure has at least

[17]Contract terms are only available since 2006 onwards after SFAS 123R was implemented. De Angelis and Grinstein (2016) show that the discretionary component of performance compensation is about half of total compensation. TDC1 also captures the portion of pay that is not explicitly reflected in the contracts.

two advantages in addition to comparability to the literature. One is that market values are what matters to shareholders, in particular to the largest institutional investors, who are typically compensated based on total assets under management. Second, when markets are reasonably efficient, market values are more informative about performance than accounting profits. Table 1 Panel A reports summary statistics about own and rival performance, sales (used to measure market shares), and volatility (a control).

**Ownership.** To construct the ownership variables, we use Thompson Reuters 13Fs, which are taken from regulatory filings of institutional owners. We describe the precise construction of the common ownership variables in the following section. A limitation implied by this data source is that we do not observe holdings of individual owners. We assume that these stakes are relatively small and in most cases do not directly exert a significant influence on firm management. Inspection of proxy statements of all firms in particular industries (Azar et al., 2015, 2016) suggests that the stakes individual shareholders own in large publicly traded firms are rarely significant enough to substantially alter the measure of common ownership concentration we use, even in the most extreme cases. For example, even Bill Gates's ownership of about 5% of Microsoft's stock is small compared to the top five diversified institutional owners' holdings, which amount to more than 23%. As a result, including or discarding the information on Bill Gates' holdings does not have a large effect on the measure of common ownership used. We thus expect that the arising inaccuracies introduce measurement noise and a bias toward zero in our regressions.[18]

Because common ownership summary statistics are a contribution in their own right, we discuss them in a separate subsection below. However, given that common ownership is the main explanatory variable of our study, some considerations on what drives the variable's variation are in order. Variation over time within and across industries in common ownership comes from any variation in the structure of the ownership network, i.e., from any change in top shareholder

[18]We are not aware of a publicly available data set that provides more accurate information on ownership for both institutions and individuals than the one we use. For example, we determined by manual inspection that ownership information provided by alternative data sources that contains individual owners (e.g., Osiris) is often inaccurate; we hence prefer regulatory data from the SEC.

positions. These changes include transactions in which an actively managed fund increases or offloads a position in an individual stock, as well as transactions in which an index fund increases its holdings across a broad set of firms because of inflows the fund needs to invest. It also includes variation from combinations of asset managers. Some of this variation could be thought of being endogenous to executive incentives. For example, an undiversified investor might accumulate a position in a single firm that has an inefficiently structured compensation policy in place, thus decreasing common ownership density, which would be followed by a change in compensation structure. Or, an investor might buy shares from undiversified investors and accumulate positions in competing firms, thus increasing common ownership density, with the aim of decreasing competition between them.[19] We will later address in the second-to-last section of this paper how the exogenous and potentially endogenous parts of the variation can be decomposed and separately used in the analysis.

**Industry Definitions.** Regarding the definition of markets and industries, we again start with the benchmark provided by the existing corporate finance literature, and then offer several refinements. Our baseline specifications define industries by four-digit SIC codes from CRSP. We construct the industry-year level $HHI$ indices based on sales from Compustat North America. For robustness, we also use the coarser three-digit SIC codes. The advantage of doing so is that broader industry definitions may be more appropriate for multi-segment firms. Two significant disadvantages are that the market definition necessarily becomes less detailed and thus less accurate for focused firms, and that the variation used decreases. We then provide alternative tests checks using the arguably more precise, 10K-text-based industry classifications of Hoberg and Phillips (2010, 2016) (HP). Albuquerque (2009) shows that splitting industries in size groups makes finding RPE easier in the data. Jayaraman et al. (2015) argue that the HP definitions provide a more precise industry classification and provide empirical evidence for RPE when using these industry definitions.[20] Therefore, to be conservative from the perspective of finding support

[19]See Flaherty and Kerber (2016) for a recent example of such conduct and a brief discussion of potential legal consequences.

[20]Relatedly, and in agreement with the literature, we do not control for firm-fixed effects, because any remaining

for our explanation, we also provide results for size-split industries, both defined by SIC codes and HP.

Despite our efforts to use robust industry definitions, we acknowledge that none of them is perfect. In general, the assumption that an industry corresponds to a market in a way that precisely maps to theory will deviate from reality, no matter whether SIC or HP classifications are used. Moreover, using Compustat to extract sales and compute market shares implies we miss private firms in our sample. Studies that focus on one industry alone and benefit from specialized data sets for that purpose can avoid or mitigate these shortcomings. However, for firm-level cross-industry studies, the imperfection implied by coarser industry definitions is unavoidable: available data sets on ownership and industries also limit existing studies in the literature to public firms. We do not have a concrete reason in mind why these limitation should lead to qualitatively misleading results, but it is advisable to keep these constraints in mind when attempting a quantitative interpretation of the results.

## C Common Ownership Across Industries and Over Time

Our sample contains yearly data from 1993 to 2014. Table 1 Panel A provides summary statistics for $HHI$ and $MHHID$ at the four-digit SIC code industry level over these years. In the average and median industry, common ownership concentration is about a quarter as large as product market concentration. However, these economy-wide summary statistics obscure the variation in both product market and ownership concentration across different sectors of the economy and over time. Panel B reports the same measures of $HHI$ and $MHHID$, but separately for each two-digit SIC code sector. More precisely, the concentration measures are computed for each four-digit industry and then averaged across these industries, for each two-digit code.

Figure I shows that there has been a significant increase in $MHHID$ for the average four-digit

variation in common ownership concentration would stem from firms switching industries. Such occurrences are rare. Moreover, we deem them more likely to be random and uninformative. As a result, we do not offer tests that rely purely on such variation.

SIC code industry in various sectors over the past two decades. In particular, in construction, manufacturing, finance, and services, the average industry $MHHID$ has increased by more 600 $HHI$ points. While this number is a lower bound due to the coarse industry definitions we use, it is three times larger than the 200-point threshold the DoJ/FTC horizontal merger guidelines find "likely to enhance market power." This increase in ownership concentration is largely decoupled from a relatively constant product market concentration. To illustrate, Figure II shows the average $HHI$ and $MHHID$ time series for the manufacturing sector where the average is taken across four-digit SIC code industry definitions.

Figure II also shows that common ownership concentration $MHHID$ can add a quantitatively large amount of concentration to standard measures of industry concentration $HHI$. At the end of our sample, in 2013, $MHHI$ is more than 1,500 points higher than $HHI$. Again, these magnitudes are likely underestimates of the true extent of increased market concentration, among others because antitrust enforcement typically considers market-level concentration measures as a proxy for competitive threats. Indeed, larger magnitudes have been reported with market-level concentration measures in the airlines and banking industry by Azar et al. (2015, 2016).

Where does this ownership concentration come from? Table 3 shows that large mutual fund companies play an important role. Panel A reports the number and fraction of firms for which a particular investor is the largest shareholder of the firm, by two-digit industry. Panel B repeats the exercise, but instead reports the proportion of firms for which a particular investor is among the top ten shareholders of the firm. Although the two panels reveal a significant amount of sectoral variation in ownership concentration, even the average magnitude of common ownership is quite large across the entire sample of firms. For example, BlackRock is now among the largest ten shareholders of almost 70% of all the firms in our sample (roughly the 2,000 largest publicly traded firms in the U.S.). Vanguard follows very close behind.

Panel C shows that the role of these investors has become more important over the last two decades. Whereas a very small proportion of firms had one of the investors listed in the panel as one of their top ten shareholders at the beginning of our sample, a very large proportion did so at the end. For example, whereas both BlackRock and Vanguard were among the top ten shareholders in almost no firms in 1994, both were among the top ten in almost 70% of the sample firms in the final years of our sample. To put that number in perspective, recall that our sample includes quite small corporations outside the S&P1,500 as well. It is less typical for large asset managers to hold large blocks of shares in that universe.

# V Panel Regressions

This section details how we translate the stylized model's predictions into empirically testable hypotheses.

## A Empirical methodology

We want to test how compensation for own performance and relative performance evaluation relate to common ownership concentration. A basic equation that defines pay-for-performance sensitivity and the sensitivity of pay to rival firms' performance is

$$\omega_{ij} = k_{ij} + \alpha_{ij}\pi_j^o + \beta_{ij}\pi_j^r + \varepsilon_{ij}, \tag{21}$$

where manager $i$ works in firm $j$, and superscript $o$ refers to own firm performance, and $r$ refers to rivals' firm performance. $\alpha_{ij}$ is the pay-for-performance sensitivity, and $\beta_{ij}$ is the sensitivity of manager $i$'s pay $\omega_{ij}$ to firm $j$'s rivals' performance. To examine how $\alpha_{ij}$ and $\beta_{ij}$ depend on product market concentration, one can extend this equation to

$$\begin{aligned}\omega_{ij} \quad = \quad & k_i + \alpha_1\pi_j^o + \alpha_2\pi_j^o F(HHI_j) + \\ & +\beta_1\pi_j^r + \beta_2\pi_{jt}^r F(HHI_j) + \\ & +\gamma_1 F(HHI_j) + \varepsilon_{ij}, \end{aligned} \tag{22}$$

where $F(HHI)$ is the industry's concentration rank, and take a particular interest in the coefficients $\alpha_2$ and $\beta_2$. Going beyond, the present paper investigates if the incentive slopes $\alpha$ and $\beta$ vary with common ownership concentration (MHHID), obtained from the generalized measure of market concentration $MHHI(= HHI + MHHID)$ introduced above. To answer this question, by contrast to some of the existing literature, we employ panel regressions, i.e., use both cross-sectional and time-series variation. In sum, our baseline empirical model is,

$$\begin{aligned}
\omega_{ijt} &= k_i + \alpha_1 \pi^o_{jt} + \alpha_2 \pi^o_{jt} F(HHI_{jt}) + \alpha_3 \pi^o_{jt} F(MHHID_{jt}) + \\
&\quad + \beta_1 \pi^r_{jt} + \beta_2 \pi^r_{jt} F(HHI_{jt}) + \beta_3 \pi^r_{jt} F(MHHID_{jt}) + \\
&\quad + \gamma_1 F(HHI_{jt}) + \gamma_2 F(MHHID_{jt}) + \varepsilon_{ijt}, \qquad (23)
\end{aligned}$$

where our interest is chiefly in the coefficients $\alpha_3$ and $\beta_3$ to test Proposition 1, and in coefficient $\gamma_2$ to test Proposition 2.

Following the literature, we also offer specifications that control for firm size (Rosen, 1982), CEO tenure (Bertrand and Mullainathan, 2001b), and stock return volatility as a proxy for operating risk (Core and Guay, 2003; Aggarwal and Samwick, 1999b). Also, time and industry fixed effects are included in all specifications. The use of time fixed effects is to mitigate the following concern: both common ownership and executive pay have increased over time, and so have a large number of other unmeasured variables. The concern is that the true driver of executive pay and common ownership is such an omitted variable. Time fixed effects difference out such an effect by making use only of the changes in the cross-sectional variation over time. Time fixed effects do not rule out, however, that a heterogeneous increase in executive pay across industries, which also experienced a differential increase in common ownership, is driven by a heterogeneous exposure to an omitted trending variable. We attempt to attenuate that concern with an instrumental variables (IV) strategy in the next section.

Industry fixed effects are included to rule out that an omitted variable that is correlated both with the cross-sectional distribution of $MHHID$ and with the level of executive pay drives the results. Specifications that include industry fixed effects identify the effect of $MHHID$ on pay from variation over time in both pay and $MHHID$, ruling out that an omitted cross-sectional common determinant of both pay structure and common ownership drives our results. In agreement with the literature (Albuquerque, 2009; Frydman and Saks, 2010; Custódio et al., 2013), we recognize that pay levels are likely to be correlated across executives within firm, and thus cluster all regressions at the firm level.

We are interested specifically in testing whether the ratio $\beta/\alpha$ from the theory is increasing in $MHHID$. To compute $\alpha$ and $\beta$ we need to differentiate the expression (23) with respect to $\pi_j^o$ and $\pi_j^r$, respectively:

$$\begin{aligned} \frac{\partial \omega_{ij}}{\partial \pi_j^o} &= \alpha = \alpha_1 + \alpha_2 F(HHI_{jt}) + \alpha_3 F(MHHID_{jt}) \\ \frac{\partial \omega_{ij}}{\partial \pi_j^r} &= \beta = \beta_1 + \beta_2 F(HHI_{jt}) + \beta_3 F(MHHID_{jt}). \end{aligned} \tag{24}$$

The final step is to differentiate the ratio $\beta/\alpha$ with respect to the c.d.f. of $MHHID$ to be able to test Proposition 1:

$$S = \frac{\partial\,(\beta/\alpha)}{\partial F(MHHID)} = \frac{(\alpha_1\beta_3 - \alpha_3\beta_1) + (\alpha_2\beta_3 - \alpha_3\beta_2) * F(HHI)}{(\alpha_1 + \alpha_2 F(HHI) + \alpha_3 F(MHHID))^2}. \tag{25}$$

Proposition 1 predicts that under both Cournot (strategic substitutes) and Bertrand (strategic complements) models of competition, $S > 0$. We test this hypothesis at the median value of the c.d.f.'s, i.e.: $F(HHI) = 0.5$ and $F(MHHID) = 0.5$.

# B Panel Regression Results

Table 4 presents the main results. We start with a benchmark result. Column (1) presents a regression of executive pay on the explanatory variables performance of own and rival firm, and those variables interacted with market concentration (HHI), corresponding to Equation (22).[21] The highly significant and positive coefficient (0.226) on *Own* [firm's performance] indicates that executives take home more pay when their firm performs better. In other words, the "pay-performance sensitivity" is positive. This effect is stronger in more concentrated industries (higher $HHI$) as we can see in the positive (0.137) coefficient of the interaction term $Own * HHI$. $HHI$ itself has no significant correlation with executive pay. The positive coefficient on *Rival* [firms' performance] indicates a lack of strong-form relative performance evaluation (RPE). The negative and highly significant $Rival * HHI$ coefficient indicates that contracts come closer to the RPE prediction when an industry's $HHI$ rank is higher.

For a quantitative interpretation of these results, note that executive compensation is denominated in thousands and firm performance is denominated in millions of constant 2015 dollars. A coefficient of 0.01 thus indicates one cent of compensation per thousand dollars of shareholder wealth. The coefficients in column (1) indicate that the (own-firm) pay-performance sensitivity ranges from 22.6 to 36.3 cents of compensation for every thousand dollars of incremental shareholder wealth per year, moving from the least concentrated ($F(HHI) = 0$) to the most concentrated industry ($F(HHI) = 1$).

These results experience a striking reinterpretation once the $HHI$ measure of market concentration is complemented with the $MHHID$ measure of common ownership concentration, corresponding to Equation (23). Recall that under the O'Brien and Salop (2000) theory, the empirically relevant concentration measure $MHHI$ is the sum of $MHHID$ and $HHI$. Hence, omitting $MHHID$ from a regression can lead to bias; a change of coefficients on $HHI$ is expected once $MHHID$ and its interactions with performance are introduced. That is indeed what we find.

Column (2) shows that the pay-performance and pay-for-rival-performance sensitivities themselves remain stable, but the previously significant interactions between pay-performance sensitiv-

[21] It most closely corresponds to the regressions in Aggarwal and Samwick (1999a). Given our vastly differing sample (they: 1992-1993, we: 1993-2014), the use of a panel data set with time and industry fixed effects in our case, and the differences in the breadth of the sample (they: manufacturing, we: all industries), the results are not expected to be comparable.

ity and pay-for-rival-performance sensitivity and $HHI$ are no longer present in the data. Moreover, the coefficients are not robust to the inclusion of controls, as columns (3) to (5) show.

The first key result is in the first three rows of column (2): the pay-for-performance sensitivity decreases, the pay-for-rival-performance increases, and unconditional pay increases when common ownership concentration ($MHHID$) increases. The formal test of the main theoretical prediction and its empirical analogue (Equation (25)) is given in Panel B: the inverse compensation ratio increases with the level of $MHHID$. The probability of a false positive is lower than 0.6 percent.

For a quantitative interpretation, when we fix industry concentration at the median ($F(HHI) = 0.5$), the own-firm pay-performance sensitivity ranges from $33 + 0.5 \cdot 5.43 = 35.72$ cents in the industry with lowest common ownership ($F(MHHID) = 0$) to $33 + 0.5 \cdot 5.43 + 11.7 = 24.02$ cents in the industry with highest common ownership ($F(MHHID) = 1$) for every thousand dollars of incremental shareholder wealth per year. Similarly, the rival-firm pay-performance sensitivity goes from $18.2 + 0.5 \cdot (-3.22) = 16.6$ in the industry with lowest common ownership to $18.2+0.5\cdot(-3.22)+14.8 = 31.4$ in the industry with highest concentration of common ownership. Moreover, executives in the most commonly owned industries receive up to \$888k (a quarter of total average pay) more than managers in the least commonly owned industries. Those appear to be quantitatively significant magnitudes.

Column (3) includes standard controls and is the most saturated specification. The pay-for-rival-performance sensitivity becomes statistically indistinguishable from zero, but the main result that relative performance evaluation (as measured by the inverse compensation ratio) decreases with common ownership is unaffected. The result that unconditional executive pay increases with $MHHID$ retains a positive point estimate but loses statistical significance.

Columns (4) and (5) reveal why this is the case: common ownership increases unconditional pay for CEOs, but not (in statistically significant ways) for non-CEO top managers. We will show shortly that this lack of significance is due to the industry definition used here. However, for both types of executives, the use of relative performance evaluation decreases with common ownership: the formal compensation ratio tests in Panel B confirm the model prediction at the

1 percent confidence level, with the exception of the CEO subsample, where confidence drops to the 5 percent level. The drop in significance is not surprising given that only about a sixth of the sample consists of CEOs.

To obtain a quantitative interpretation of the coefficients in column (3), we again fix industry concentration at the median. The own-firm pay-performance sensitivity drops from $23+0.5\cdot(-6) = 20$ cents in the least commonly owned industry to $23 + 0.5 \cdot (-6) - 9.18 = 11.82$ cents in the most commonly owned industry, for every thousand dollars of incremental shareholder wealth per year. The rival-firm pay-performance sensitivity ranges from $-1.83 + 0.5 \cdot (6.76) = 1.55$ cents in the least commonly owned industry to $-1.83 + 0.5 \cdot (6.76) + 10.6 = 12.15$ cents in the most commonly owned industry.

The above results used CRSP 4-digit SIC codes as the industry definition. Previous research has shown great sensitivity of RPE tests to industry definitions. We are therefore interested in examining how the correlations between common ownership and pay structure depend on alternative industry definitions.

Table 5 examines the robustness of our results to different industry definitions. The first column replicates specification (3) from Table 4 with full controls for easier comparison. Column (2) refines the definition of the rival group as the size tertile within the 4-digit SIC code. The only significant difference of interest is that the $MHHID$ coefficient becomes highly significant, indicating that also the average executive (i.e., not only CEOs) receives more pay that is unrelated to performance when we refine the industry definition. This fact raises our confidence about the validity of the prediction: attenuation bias could explain the lower significance levels in the previous specifications that use coarser, and thus presumably less accurate, industry definitions.

This refinement of the rival group definition also alleviates another concern. One might reasonably hypothesize that there is a greater incidence of industry classification errors for larger firms, because those are more likely to operate in multiple segments. At the same time, common ownership is partially driven by index funds and could therefore have a correlation with firm size. Also, CEO pay tends to increase with firm size. Taken together, these considerations might lead to a worry about a positive bias in the $MHHID$ by an imperfect size control.[22] The fact that the results become stronger, not weaker, when tests are explicitly run within size groups, alleviates this concern.

Columns (3) and (4) use the Hoberg and Phillips (2010) (HP) industry definition, first as is and then with the size-split refinement. The coefficient on $Rival * MHHID$ becomes statistically insignificant in both cases. The compensation ratio test loses significance (but retains its sign) in column (3) but regains a one percent level of statistical significance when the finer industry definition is used in column (4).

We find this result remarkable for two reasons. One is, as previously explained, that Albuquerque (2009) shows that relative performance evaluation becomes more prevalent with size splits, which should work against finding support for our model. However, the results in the literature of course omit $MHHID$. Once common ownership is included, consistent with the interpretation that size splits increase the accuracy of industry definitions, the statistical significance of the results confirming the model predictions increases. The second reason is that the results, by contrast to some in the literature, are robust across SIC and HP definitions.

A last set of industry definitions uses coarser classifications instead. The intuitive motivation is that many firms operate and compete in multiple segments. A coarser industry classification may decrease the probability that a firm's industry is inappropriately classified, thus reducing attenuation bias, and increasing the significance of results. An alternative interpretation, more consistent with the industrial organization literature, would be more akin to a placebo test: coarser industry classifications are necessarily less precise. Columns (5) and (6) report such results for SIC and HP classifications, respectively. The point estimates are the same, but significance levels in general are lower. We interpret these results to be consistent with coarser industry definitions being less precise, and supporting the "placebo" interpretation.

[22] A concern about the pay-for-(rival-)performance coefficients could be constructed similarly, although it would require additional levels of joint correlations.

## C Robustness to the Measures of Pay and Common Ownership

In Table 5 we used different industry classifications. We next vary the measure of pay used as the outcome variable. Our previous specifications used the "flow" of total pay (TDC1 in Execucomp), however for most executives this is only a portion of their total incentives. Changes in the value of formerly granted stock and option packages are another, often very large, component of what managers may care about. If the correlation between the "stock" and "flow" component of pay with the correlation of $MHHID$ and pay-for-(rival-)performance was systematically different, the previous results might be misleading about the effectiveness of the incentives in place. While we have no particular reason in mind why that would be the case, it is clearly important to investigate as far as possible whether this consideration has a potential major impact on our results.

To that end, in Appendix Table 1 , we use the Edmans et al. (2009) measures of *wealth*-performance sensitivity as the dependent variable, and examine how they depend on $MHHID$, controlling for $HHI$ and size (as in said paper). The point estimate of the coefficient varies with the specification and measure used, but the qualitative direction is very robust: the wealth-performance sensitivity is lower in industries with more common ownership.[23]

Ideally, we would also want to correlate a measure of wealth with rival firms' performance. However, because it is not clear how to reasonably construct a wealth-to-rival-performance measure (given the unobservability of executives' entire portfolios such as index fund investments etc.), we cannot test whether the sensitivity of executive wealth to rival firms' performance also moves in the expected direction. Given the strong results in Appendix Table 1 , however, it appears almost inconceivable that the results would be so strongly opposed to the findings so far as to overturn their qualitative conclusions.

So far we have shown robustness of the main results to alternative industry definitions, and

[23] Our results are also robust to using an alternative measure of total pay from Execucomp, TDC2, which estimates the value of total compensation *realized* by the executive in a given year.

to alternative measures of managerial incentives. The last major category of robustness checks is with respect to the measure of common ownership. Whereas $MHHID$ is the most realistic measure we are aware of in the literature, it comes with assumptions, which may not hold in practice. One important assumption is that it takes market shares to be exogenous. At first glance, it may seem paradoxical to use a measure of competition that takes market shares to be exogenous: competitive strategies will affect market shares. Upon inspection, however, doing so should not lead to a concern about false positive findings. The theory on which the $MHHID$ is based, reviewed briefly above, predicts a positive effect of $MHHID$ on price-cost margins, and market shares positively enter the $MHHID$. However, when a firm raises prices, it should lose market share, leading to lower $MHHID$. Hence, the endogeneity of market shares works against the predictions of the common ownership model.

Nevertheless, we want to investigate how much our main results depend on this measure of common ownership. To that end, in Appendix Table 2 we run regressions similar to those in Tables 4 and 5. The difference is that we calculate $MHHID$ assuming that each firm in the industry has a market share of one divided by the number of firms in the industry.[24] We show these regressions both with and without controls, and for both SIC and HP industry definitions. Moreover, we use the most detailed industry measure (size splits similar to Albuquerque (2009)) which the existing literature has shown to be most conducive to finding evidence for relative performance evaluation (i.e., the opposite of what the alternative theory we propose predicts).

Let us first examine what we should expect to see under the different hypotheses. Under the null hypothesis that the O'Brien and Salop (2000) model is correct, equal-weighting makes for a less precise but directionally correct measure of common ownership, which should attenuate coefficients.[25] In contrast, under the hypothesis that the standard model is right, and all our

[24] We are grateful to Daniel Ferreira for suggesting this measure.

[25] The reason for the expected attenuation is that a measure of common ownership that assigns equal market shares to all firms fails to distinguish between the following two situations. In both cases, there are three firms: A, B, and C. A and B have 45% market share, and C has 10%. If there is perfect common ownership between A and B, the industry is practically monopolized. If there is common ownership between A and C and B or C, by contrast, common ownership is not very important in the industry. The variation across these two scenarios in the importance of common ownership is entirely ignored by a measure of common ownership concentration that

results are driven by the endogenous nature of market shares, the test should produce pure noise.

The coefficients in Appendix Table 2 indicate that the potential endogeneity of market shares is not the main driver of the results. A market-share free measure of common ownership does not lead to a reversal of our conclusion. All coefficients of interest retain their direction, albeit some drop a level of significance. However, the compensation ratio test remains significant even at 3 percent levels.

## D Remaining Concerns

One remaining concern may be that sorting of executives with particular characteristics and preferences could be driving the results and change the interpretation. For example, less aggressive CEOs might sort into firms that are held by index funds and that (for an unexplained reason other than their economic incentives) also systematically offer "flatter" compensation packages. While we think that this is a plausible story our conclusions are entirely unaffected: the purpose of the paper is to show that in firms whose largest owners are widely diversified, managers "get away" with flatter pay structures because there are no powerful undiversified shareholders in whose interest and power it is to change them. In sum, given that this is part of the explanation we propose, we do not intend to challenge such a sorting hypothesis.

Relatedly, one might suspect that a mechanical relationship exists between executive pay and stock performance, and that there is also a mechanical relationship between stock performance and measures of common ownership concentration such as the $MHHID$. One would suspect that this mechanic plays a greater role for the "stock" pay measure we use in the robustness checks than for the "flow pay" used in the baseline specifications. However, this should not be a concern in either case. The whole point of relative performance evaluation is that such mechanical effects are supposed to be differenced out by the optimal contract, in all industries and at all times. The point of the present paper is that shareholders have reduced incentives to do so in industries with

ignores market shares altogether.

more common ownership, and the empirical results are consistent with that logic.

A relevant remaining concern, however, is that reverse causality is driving these correlations, or (more likely) that an omitted variable that determines both $MHHID$ and the structure of CEO pay both in the time series and in the cross section is the true cause for these patterns. The following section attempts to alleviate such concerns by using variation in ownership that was caused by a mutual fund trading scandal, and is therefore plausibly exogenous to compensation contracts.

# VI IV Strategy and Results

## A An Exogenous Change in Common Ownership

The motivating theory of this paper treats common ownership $1-x$ as an exogenous parameter. However, real-world ownership patterns are endogenously determined and could potentially be related to top management incentives, be that because of their effect on competition or for other reasons. As a result, the correlations from the previous section's panel regression results cannot necessarily be interpreted causally. This section uses a subset of the variation in ownership, namely that stemming from a mutual fund trading scandal which was plausibly exogenous to both compensation contracts and competition. That variation is more difficult to attribute to endogenous forces. Hence, if changes of ownership that derive from this shock correlate in similar ways with changes in executive pay levels and structures, the reverse causality and omitted variable concerns are attenuated.

The instrument, previously employed by Anton and Polk (2014), relies on the mutual fund trading scandal of 2003, in which funds from 25 mutual fund families were accused of engaging in late trading and market timing. The affected families included well-known and large firms such as Janus, Columbia Management Group, Franklin Templeton, etc. The news became public in September 2003. Investors aggressively pulled out money from those families over the following months. Of course, the capital does not disappear but merely gets reallocated; when one fund sells, another one buys. Indeed, while the shock increased common ownership in some industries, it decreased it in others. Such variation is useful for identification purposes.

Kisin (2011) shows that the effect of withdrawals lasted until December 2006, and that outflows of implicated families amounted to 14% the first year, and over 21% the second year. Implicated families had an aggregate amount of assets under management of \$236.5b, which amounts to 24.8% of the US mutual fund universe. Hence, it is reasonable to hypothesize that the shock had a significant effect on ownership structures, and hence optimal contracts, until about 2006. We test if that hypothesis has empirical support, and if there is empirical support for the further hypothesis that changes in common ownership density induced by the shock alone (i.e., not using the actual changes in common ownership) are correlated with lower relative performance evaluation and higher unconditional pay.

Specifically, total common ownership concentration $MHHID$ can be decomposed into common "scandal" ownership and common "non-scandal" ownership. We first calculate

$$MHHID_{Scandal} = \sum_j \sum_{k \neq j} s_j s_k \frac{\sum_i \gamma_{ij} \beta_{ik}}{\sum_i \gamma_{ij} \beta_{ij}},$$

where in the numerator, $\sum_i \gamma_{ij} \beta_{ik}$, we sum only across scandal funds, whereas in the denominator, $\sum_i \gamma_{ij} \beta_{ij}$, we sum across all funds. Our instrument is the ratio of scandalous common ownership over all common ownership in September 2003 at the time of the scandal

$$ScandalRatio = \frac{MHHID_{Scandal}}{MHHID}.$$

In addition to instrumenting for $MHHID$, we also instrument for its interactions with own performance and rival performance, by multiplying the $ScandalRatio$ with own and rival performance. Consequently, we report three first-stage regressions, where dependent variables are $F(MHHID_{jt})$, $\pi^o_{jt} F(MHHID_{jt})$, and $\pi^r_{jt} F(MHHID_{jt})$, each in the years 2004 until 2006. We provide the results both for SIC and for HP industry classifications, making for six specifications in total. The second stage will regress CEO total compensation on the fitted values from the first-stage regression, for the same years as for the first stage.

The identifying assumption is that the *ScandalRatio* in 2003 is not related to how firms were planning (and going) to set compensation levels and sensitivities in the years to come, and in particular that the firms in industries with high *ScandalRatio*s were planning to set flatter pay schedules. We are not aware of an obvious reason consistent with the actors' economic incentives why that assumption should be systematically violated.

The results of the first stage regression are in Table 6. The main observation is that there is a statistically highly significant relationship between the *ScandalRatio* and $MHHID$. Owing to the different industry definitions, the ratio takes the opposite sign in column (1) than in column (4), but is also highly significant. The *ScandalRatio* interaction with profits and rival profits is likewise highly significant. Panel B shows the different tests for underidentification and weak identification for each endogenous regressor. In this setting with multiple endogenous variables, the conventional first stage F statistics are not appropriate (Angrist and Pischke, 2009). Therefore, we provide the adjusted test proposed by Sanderson and Windmeijer (2016). We can reject the null hypothesis that the endogenous regressors are "weakly identified." Furthermore, we report the Kleibergen and Paap (2006) Wald test for the full model which yields similar conclusions.

Results of the second stage regression are in Table 7. We report results for all executives and for non-CEOs for SIC and HP industry classifications. (Owing to the restriction to only 3 years of data, the sample for CEOs alone is too small for the tests to have statistical power.) The coefficients on the interaction of $MHHID$ and own profits are negative, and significant at 5 percent levels in the SIC specifications. The coefficient on $MHHID$ interacted with rival performance is positive throughout but marginally significant only in the HP specifications. The crucial statistic for our hypothesis test is reported in Panel B. Across all specifications, the inverse compensation ratio is positive and highly statistically significant.

Importantly for the test of the theory's second main prediction, the effect of $MHHID$ on the level of executive pay is highly significant and economically large across all specifications, corroborating the results from the panel analysis.

These results do not rule out, but attenuate, the identification concerns that remained after the fixed-effects panel regressions. We conclude that it is likely that there is a causal effect of common ownership concentration, as measured by $MHHID$, on a reduced propensity to use RPE.

In sum, we provided statical evidence supporting a causal interpretation of the correlation between common ownership and anticompetitive managerial incentives. In the introduction, we also provided anecdotal evidence that large shareholders put much effort and thought into questions of executive compensation and competition between portfolio firms. The accumulated evidence strongly suggests that common owners consciously act to maximize their economic incentives. Notwithstanding, our results are also consistent with a seemingly more benign interpretation that large mutual funds are "lazy owners" (Economist, 2015) that do nothing other than allowing management to live a quiet life (Bertrand and Mullainathan, 2003) with flat incentives, high profit margins, and little competition. In fact, they may help to achieve such an outcome simply by crowding out and occasionally voting against activist investors who would otherwise attempt to induce tougher competition.[26] Importantly, however, such a difference in interpretations is inconsequential. The intent of investors is irrelevant both for the question of whether there is a causal effect of their ownership on managerial incentives, and it is likewise irrelevant for most legal consequences. We elaborate on interpretations and consequences of our results in the following, and last remaining, section.

# VII Conclusion

In this paper, we showed that the combination of large-shareholder diversification and imperfect competition has a profound impact on the structure of top management incentives. Specifically, we found that managers receive less pay for own-firm performance and relatively more for rivals'

[26] Schmalz (2015) discusses a potential occurrence of such an event.

performance when the firm's shareholders own large stakes in their rivals. We thus illustrated the power of relaxing an important assumption present in most models in corporate finance – that product markets are perfectly competitive – while retaining the more common assumption that sophisticated shareholders are diversified across firms. Given that top managers are the agents charged with implementing the shareholders' objectives, these results also shed light on the question how firm's effective objective functions change with a change in their shareholder composition.

That question has largely been ignored by the empirical literature – despite strong theoretical reasons to critically examine the ubiquitous assumption that all firms always act to maximize their own value (Wilson, 1972; Leland, 1974). That gap in the literature is perhaps due to a combination of history and convenience. In particular, the Fisher Separation Theorem (FST) (Fisher, 1930) states that as long as certain conditions are met, the firm's objective is to maximize its own profits. One of the conditions needed is that firms are price takers. The reason is that, whereas shareholders may disagree about what the firm should do (perhaps because of heterogeneous portfolios), such disagreements have no impact when firms are price takers and there is simply nothing to strategize or disagree about. This and other limitations of the assumption that firms maximize own profits are well known in theory (DeAngelo, 1981; Milne, 1981), but the empirical literature has nonetheless embraced this assumption.[27] The reason may be that the assumption affords tremendous simplifications and therefore is convenient for empirical researchers. For example, if the FST holds, heterogeneity in shareholder portfolios and preferences can be safely ignored in analyses of corporate policies; which voting scheme or other mechanism resolves shareholder conflicts is a question that need not be addressed.

However, not only do these seem to be interesting questions to pursue, but our results also indicate in the context of managerial compensation contracts that assuming that firms maximize

[27] There is a literature in corporate finance that focuses on interactions between imperfect competition and financial strategy, and another literature in organizational economics on imperfect competition and optimal contracts. However, those literatures tend to assume implicitly that shareholders do not diversify across competitors, or that such diversification is inconsequential, by assumption.

their own profits can lead to qualitatively opposing interpretations of empirical patterns and their economic drivers. It appears likely that a similar change of perspective could occur when researchers in other sub-fields of corporate finance recognize the potential for an empirical failure of the FST. Indeed, by providing evidence consistent with the idea that the FST's predictions are not always empirically valid, we attempt to illustrate a great untapped potential for empirical work in corporate finance that results from relaxing the theorem's assumptions.

A more pragmatic contribution of our paper is to answer a specific research question at the intersection of finance and industrial organization. The open question was which mechanism can induce the anticompetitive product market behavior of firms that arises from common ownership (Azar et al., 2015) and ultimate ownership (the combination of common ownership and cross-ownership) (Azar et al., 2016). The answer we propose is that managerial incentive contracts can give managers economic reasons to act in their shareholders' anticompetitive interests.

We also provided evidence on engagement meetings, voting patterns, and coordination of corporate governance activities among large, previously-perceived-to-be-passive shareholders. However, we have merely pushed the boundary of knowledge forward by a small step. We have provided qualitative but not quantitative evidence on how the contracts whose outcomes we measure are brought about. Finding direct evidence for the forces behind these contracts would likely require information about the precise content of engagement meetings. Unfortunately for researchers, these meetings are designed to be private. Regulatory records that are currently being obtained as part of a federal antitrust investigation (McLaughlin and Schlangenstein, 2015) may become available in the future. Given the uncertainty of access to this data, we leave this and related questions for future research.

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# Figures

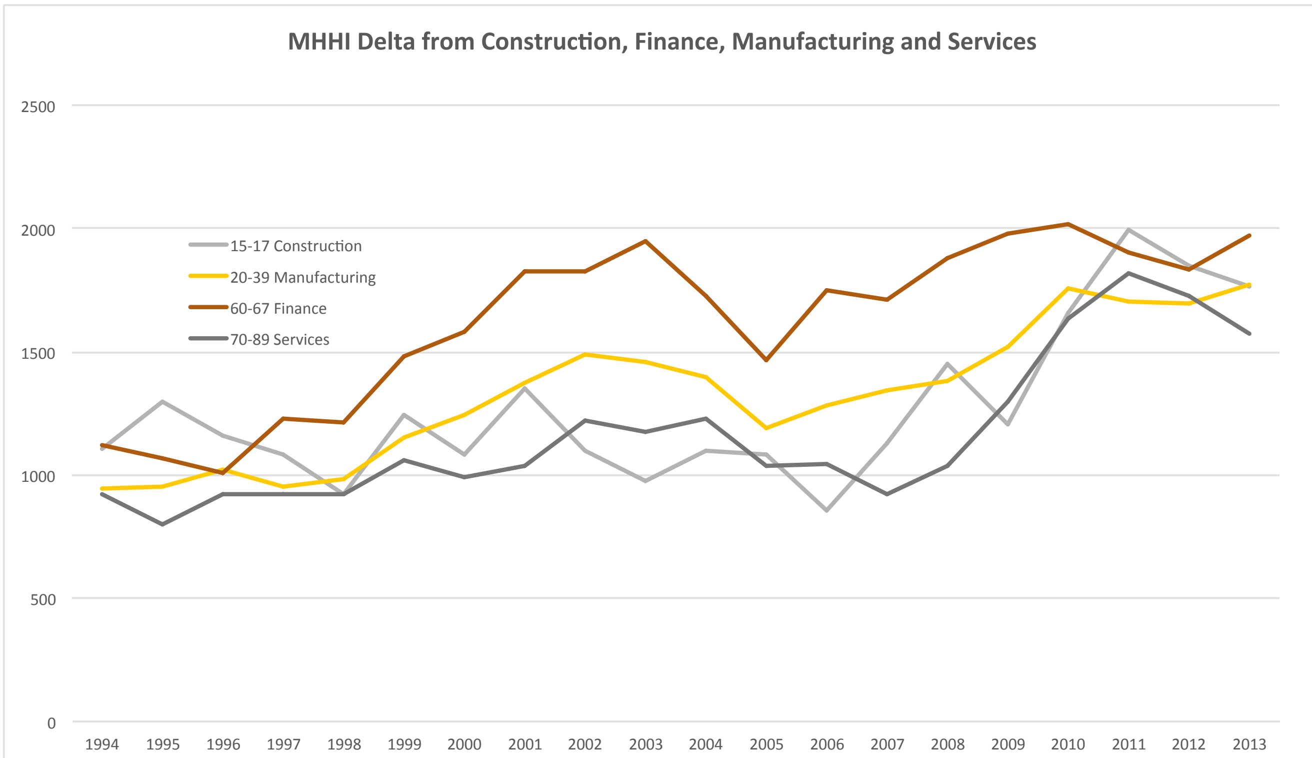


**Figure I. Common Ownership Concentration (MHHID) in Various Sectors Over Time.**
This figure plots the ownership concentration as measured by $MHHID$ averaged across four-digit SIC code industries for various sectors (construction, manufacturing, finance, and services) for the years 1994 to 2013.

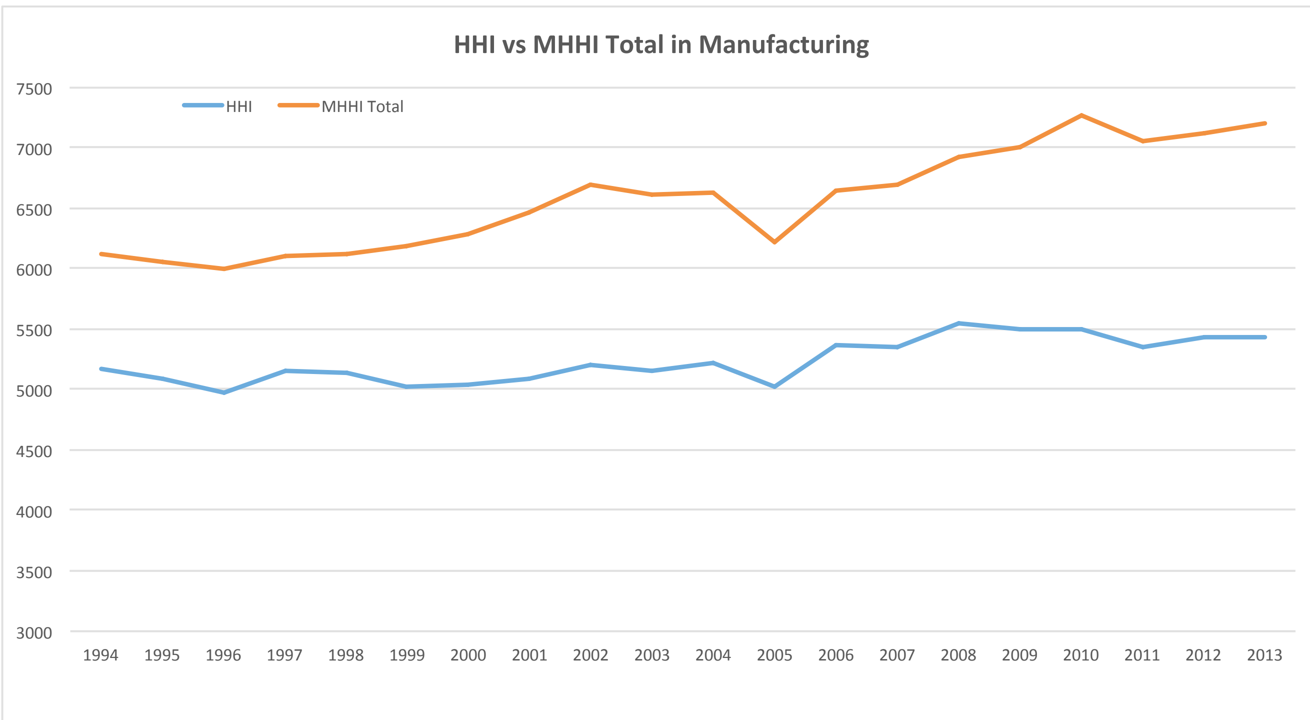


**Figure II. Four-digit SIC HHI versus MHHI over time in Manufacturing.**
This figure plots the product market and ownership concentration in manufacturing industries as measured by $HHI$ and $MHHID$ averaged across four-digit SIC code industries in manufacturing for the years 1994 to 2013.

# Tables

**Table 1.** Summary Statistics for Key Variables.

We report the average and other summary statistics for the variables at the manager level (total compensation and tenure), at the firm level (performance, size, and volatility), and at the industry level (HHI and MHHI Delta).

| Variables | N | Mean | Median | Std | 10% | 90% |
|---|---|---|---|---|---|---|
| *At the manager level* | | | | | | |
| TDC1 (Compensation ’000) | 223605 | 2308 | 1364 | 2413 | 411 | 5967 |
| Tenure (years) | 252443 | 4.6 | 3 | 3.7 | 1 | 10 |
| *At the firm level* | | | | | | |
| Own Performance | 39426 | 521.8 | 119.8 | 1693.7 | -822 | 2607.2 |
| Rival Performance (SIC4) | 36797 | 504.3 | 108.7 | 1528.1 | -639.4 | 2301.2 |
| Log(Sale) | 41760 | 7.06 | 6.99 | 1.66 | 5.08 | 9.25 |
| Volatility | 38249 | 0.1218 | 0.1075 | 0.0639 | 0.0598 | 0.2014 |
| *At the industry level (SIC4)* | | | | | | |
| HHI | 9340 | 4814 | 4674 | 2942 | 853 | 8963 |
| MHHI Delta | 9340 | 1437 | 1140 | 1285 | 94 | 3203 |

**Table 2. Panel A:** Cross-sectional Variation of Production Market ($HHI$) and Common Ownership ($MHHI$ $Delta$) Concentration Across and Within industries.

This table reports summary statistics for product market and ownership concentration for the average two-digit SIC industry, whereas averages are taken across four-digit SIC industries.

| | | | HHI | | | MHHI Delta | | |
|---|---|---|---|---|---|---|---|---|
| Main SIC group and Description | # of 4-digit SIC in 2013 | # of 4-digit SIC-Years | Mean | 10% | 90% | Mean | 10% | 90% |
| 01-09 Agriculture, Forestry, Fishing | 4 | 214 | 6882 | 5314 | 9955 | 448 | 4 | 1260 |
| 10-14 Mining | 77 | 1684 | 4510 | 1174 | 8806 | 1609 | 24 | 3504 |
| 15-17 Construction | 24 | 981 | 4761 | 1542 | 8168 | 1204 | 60 | 2719 |
| 20-39 Manufacturing | 707 | 23761 | 5247 | 2230 | 8949 | 1253 | 53 | 2932 |
| 40-49 Transportation & Public Utilities | 152 | 4184 | 3826 | 1028 | 7211 | 1797 | 133 | 3831 |
| 50-51 Wholesale Trade | 107 | 3222 | 5034 | 2346 | 8660 | 1272 | 60 | 2839 |
| 52-59 Retail Trade | 120 | 3903 | 4552 | 1669 | 7887 | 1452 | 141 | 3157 |
| 60-67 Finance, Insurance, Real Estate | 168 | 5241 | 3817 | 1017 | 7908 | 1520 | 82 | 3618 |
| 70-89 Services | 246 | 7409 | 4722 | 1681 | 8576 | 1113 | 62 | 2518 |

**Table 2. Panel B:** Time-series variation of Production Market ($HHI$) and Common Ownership ($MHHI$ $Delta$) Concentration, by Industry.

This table reports the the variation over time in the conventional $HHI$ measure of product market concentration and the additional piece to concentration stemming from common ownership, $MHHI$ $Delta$, in various industries. The concentrations numbers are averages across four-digit SIC industries, for each two-digit SIC industry group.

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-09 Agriculture, Forestry, Fishing | HHI | 6945 | 6858 | 6370 | 6198 | 6842 | 6543 | 6134 | 5802 | 5808 | 5620 | 8048 | 7991 | 8462 | 9972 | 9491 | 8011 | 7747 | 9961 | 9987 | 9991 |
| | MHHID | 393 | 818 | 417 | 139 | 94 | 358 | 1016 | 926 | 361 | 675 | 47 | 305 | 90 | 0 | 2 | 231 | 604 | 8 | 2 | 0 |
| 10-14 Mining | HHI | 4746 | 4203 | 4481 | 4816 | 4579 | 4814 | 4796 | 4156 | 4375 | 4096 | 4509 | 3761 | 4837 | 4563 | 4965 | 4585 | 4173 | 4230 | 4081 | 4487 |
| | MHHID | 1227 | 1920 | 1706 | 1418 | 1307 | 1241 | 1764 | 1502 | 1703 | 1933 | 1533 | 1066 | 1460 | 1404 | 1700 | 1578 | 2224 | 2047 | 1981 | 1899 |
| 15-17 Construction | HHI | 4359 | 4223 | 4922 | 4149 | 4071 | 3517 | 4044 | 4634 | 4808 | 4839 | 4773 | 5039 | 4799 | 5699 | 5929 | 4998 | 5611 | 4234 | 3959 | 4040 |
| | MHHID | 1103 | 1299 | 1158 | 1080 | 923 | 1242 | 1080 | 1351 | 1101 | 980 | 1099 | 1085 | 856 | 1131 | 1449 | 1206 | 1655 | 1998 | 1847 | 1763 |
| 20-39 Manufacturing | HHI | 5173 | 5095 | 4973 | 5152 | 5139 | 5028 | 5044 | 5094 | 5206 | 5155 | 5222 | 5030 | 5362 | 5355 | 5542 | 5490 | 5503 | 5349 | 5426 | 5428 |
| | MHHID | 942 | 953 | 1025 | 953 | 985 | 1151 | 1246 | 1377 | 1492 | 1460 | 1398 | 1188 | 1280 | 1345 | 1379 | 1516 | 1761 | 1705 | 1700 | 1771 |
| 40-49 Transportation & Public Ut. | HHI | 4298 | 4503 | 4152 | 3803 | 3643 | 3557 | 3399 | 3246 | 3388 | 3482 | 3795 | 3754 | 3470 | 3881 | 3802 | 3760 | 3714 | 3893 | 3967 | 3868 |
| | MHHID | 1557 | 1447 | 1363 | 1434 | 1318 | 1563 | 1726 | 1845 | 2400 | 2374 | 1999 | 1335 | 1781 | 1942 | 1884 | 2228 | 2239 | 2398 | 2111 | 2322 |
| 50-51 Wholesale Trade | HHI | 5223 | 4884 | 4689 | 4876 | 4459 | 4323 | 4752 | 4549 | 4292 | 4366 | 4751 | 5079 | 5428 | 5442 | 5373 | 5809 | 5590 | 5702 | 5465 | 5469 |
| | MHHID | 882 | 864 | 951 | 765 | 944 | 1036 | 1287 | 1358 | 1947 | 1811 | 1584 | 1706 | 1642 | 1395 | 1674 | 1449 | 1790 | 1587 | 1405 | 1540 |
| 52-59 Retail Trade | HHI | 3960 | 4052 | 4204 | 4404 | 4221 | 4459 | 4590 | 4454 | 4507 | 4178 | 4298 | 4443 | 4772 | 4862 | 4724 | 5051 | 4714 | 4379 | 4623 | 4577 |
| | MHHID | 1102 | 1224 | 1372 | 1211 | 1330 | 1293 | 1423 | 1438 | 1645 | 1957 | 1949 | 1578 | 1596 | 1282 | 1449 | 1542 | 1902 | 1908 | 1770 | 2243 |
| 60-67 Finance, Insurance, Real Estate | HHI | 3736 | 3708 | 3724 | 3545 | 3534 | 3693 | 3462 | 3220 | 3629 | 3603 | 3867 | 3886 | 4455 | 4393 | 4253 | 3971 | 3866 | 3909 | 3722 | 3693 |
| | MHHID | 1121 | 1068 | 1009 | 1226 | 1216 | 1485 | 1579 | 1826 | 1829 | 1948 | 1725 | 1468 | 1753 | 1712 | 1880 | 1981 | 2016 | 1903 | 1837 | 1968 |
| 70-89 Services | HHI | 4766 | 4827 | 4601 | 4378 | 4202 | 4354 | 4507 | 4489 | 4627 | 4344 | 4502 | 4716 | 4629 | 4984 | 4983 | 5162 | 4929 | 4813 | 4667 | 4952 |
| | MHHID | 926 | 799 | 919 | 926 | 924 | 1060 | 989 | 1039 | 1225 | 1173 | 1231 | 1038 | 1043 | 925 | 1039 | 1296 | 1639 | 1817 | 1728 | 1572 |

**Table 3. Panel A:** Fraction of Firms in which Investor X is the Largest Shareholder, by Industry.

This table reports the average proportion of firms in two-digit SIC industries for which a given investor is the largest shareholder as of June 2013.

| | | **2-digit SIC Industries** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Firms with top shareholder* | **01-09** Agriculture, Forestry, Fishing | **10-14** Mining | **15-17** Construction | **20-39** Manufact | **40-49** Transport Public Utilit | **50-51** Wholesale Trade | **52-59** Retail Trade | **60-67** Finance, Insurance, Real Estate | **70-89** Services |
| BlackRock | 655 | 7.7% | 12.9% | 26.0% | 16.6% | 20.7% | 12.5% | 11.4% | 16.9% | 10.4% |
| Vanguard | 222 | 0.0% | 2.7% | 0.0% | 3.9% | 4.8% | 1.8% | 5.2% | 10.9% | 2.4% |
| State Str | 25 | 0.0% | 0.0% | 0.0% | 1.1% | 1.0% | 0.0% | 0.5% | 0.3% | 0.2% |
| Dimensional Fund Advisors | 193 | 0.0% | 2.7% | 4.0% | 5.4% | 2.7% | 5.4% | 5.7% | 5.8% | 2.7% |
| The Northern Trust Co. | 4 | 0.0% | 0.7% | 0.0% | 0.1% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| Fidelity | 347 | 7.7% | 3.7% | 10.0% | 8.9% | 4.1% | 14.3% | 18.0% | 5.7% | 10.9% |
| Mellon Asset Management | 10 | 0.0% | 0.3% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.2% | 0.2% |
| Wellington | 146 | 0.0% | 2.7% | 4.0% | 2.4% | 2.4% | 1.8% | 0.9% | 7.3% | 2.1% |
| T. Rowe Price | 175 | 0.0% | 3.4% | 6.0% | 4.0% | 3.1% | 2.7% | 10.9% | 2.5% | 6.0% |
| JP Morgan | 30 | 0.0% | 1.0% | 2.0% | 0.7% | 1.0% | 1.8% | 0.9% | 0.2% | 0.9% |
| Royce & Associates | 97 | 15.4% | 1.4% | 2.0% | 3.8% | 1.0% | 5.4% | 3.8% | 0.9% | 1.2% |
| Renaissance Tech. Corp | 67 | 0.0% | 0.0% | 2.0% | 2.3% | 2.2% | 3.6% | 0.5% | 0.0% | 2.7% |
| Invesco | 20 | 0.0% | 1.4% | 2.0% | 0.6% | 0.2% | 0.9% | 0.5% | 0.1% | 0.5% |
| Capital Group | 116 | 0.0% | 4.4% | 2.0% | 3.6% | 4.1% | 0.0% | 2.8% | 1.5% | 1.7% |
| Goldman Sachs | 19 | 0.0% | 1.0% | 0.0% | 0.3% | 0.5% | 0.9% | 0.0% | 0.5% | 0.5% |

**Table 3. Panel B:** Fraction of Firms in which Investor X is among the Largest Ten Shareholders, by Industry.

This table reports the average proportion of firms in two-digit SIC industries for which a given investor is among the largest ten shareholders as of June 2013.

| | | **2-digit SIC Industries** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Firms with top 10 shareholder (Universe of 4676 firms)* | **01-09** Agriculture, Forestry, Fishing | **10-14** Mining | **15-17** Construction | **20-39** Manufact | **40-49** Transport Public Utilit | **50-51** Wholesale Trade | **52-59** Retail Trade | **60-67** Finance, Insurance, Real Estate | **70-89** Services |
| BlackRock | 3025 | 54% | 53% | 80% | 76% | 68% | 70% | 86% | 69% | 72% |
| Vanguard | 3038 | 46% | 51% | 74% | 77% | 61% | 72% | 85% | 72% | 74% |
| State Str | 1625 | 38% | 33% | 34% | 39% | 39% | 30% | 58% | 42% | 30% |
| Dimensional Fund Advisors | 1531 | 38% | 24% | 42% | 38% | 29% | 43% | 42% | 41% | 33% |
| The Northern Trust Co. | 904 | 23% | 17% | 12% | 22% | 25% | 26% | 18% | 27% | 14% |
| Fidelity | 1292 | 23% | 26% | 38% | 31% | 25% | 37% | 41% | 27% | 35% |
| Mellon Asset Management | 655 | 8% | 8% | 14% | 18% | 19% | 15% | 22% | 15% | 10% |
| Wellington | 787 | 8% | 16% | 26% | 18% | 13% | 17% | 20% | 24% | 17% |
| T. Rowe Price | 753 | 0% | 15% | 22% | 20% | 17% | 13% | 25% | 14% | 19% |
| JP Morgan | 539 | 8% | 14% | 12% | 11% | 17% | 17% | 19% | 13% | 11% |
| Royce & Associates | 533 | 31% | 7% | 16% | 20% | 6% | 22% | 13% | 6% | 11% |
| Renaissance Tech. Corp | 680 | 31% | 11% | 10% | 20% | 16% | 16% | 18% | 10% | 20% |
| Invesco | 478 | 15% | 8% | 18% | 11% | 13% | 5% | 11% | 12% | 12% |
| Capital Group | 451 | 8% | 12% | 10% | 12% | 14% | 4% | 12% | 8% | 11% |
| Goldman Sachs | 371 | 0% | 10% | 10% | 7% | 13% | 10% | 4% | 12% | 6% |

**Table 3. Panel C:** Fraction of Firms in which Investor X is among the Largest Ten Shareholders, over Time.

This table reports the average proportion of US corporations for which a given investor is among the largest ten shareholders.

| *TOP 10 BLOCKHOLDERS* | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BlackRock | 0% | 0% | 0% | 0% | 0% | 0% | 1% | 1% | 0% | 0% | 1% | 3% | 3% | 8% | 9% | 9% | 69% | 72% | 71% | 69% |
| Vanguard | 0% | 0% | 0% | 10% | 12% | 17% | 25% | 30% | 35% | 32% | 36% | 37% | 41% | 45% | 54% | 65% | 65% | 66% | 69% | 68% |
| State Str | 13% | 8% | 7% | 8% | 10% | 10% | 15% | 19% | 23% | 32% | 31% | 20% | 22% | 23% | 26% | 33% | 37% | 37% | 37% | 36% |
| Dimensional Fund Advisors | 29% | 31% | 32% | 34% | 34% | 36% | 36% | 35% | 38% | 37% | 31% | 32% | 33% | 34% | 39% | 42% | 39% | 37% | 36% | 33% |
| The Northern Trust Co. | 2% | 2% | 1% | 1% | 2% | 10% | 11% | 14% | 18% | 22% | 18% | 13% | 10% | 8% | 8% | 16% | 20% | 17% | 20% | 20% |
| Fidelity | 25% | 26% | 24% | 23% | 23% | 21% | 21% | 23% | 25% | 28% | 29% | 26% | 29% | 28% | 29% | 30% | 31% | 30% | 29% | 30% |
| Mellon Asset Management | 25% | 24% | 23% | 24% | 24% | 21% | 23% | 22% | 19% | 17% | 16% | 15% | 15% | 12% | 13% | 16% | 15% | 15% | 15% | 14% |
| Wellington | 10% | 11% | 11% | 11% | 12% | 12% | 12% | 14% | 16% | 16% | 17% | 17% | 20% | 19% | 19% | 17% | 19% | 20% | 19% | 18% |
| T. Rowe Price | 5% | 5% | 6% | 7% | 8% | 8% | 8% | 9% | 10% | 10% | 11% | 11% | 13% | 14% | 14% | 16% | 15% | 17% | 18% | 17% |
| JP Morgan | 7% | 6% | 6% | 6% | 7% | 0% | 5% | 10% | 8% | 6% | 5% | 8% | 8% | 9% | 8% | 8% | 9% | 10% | 12% | 12% |
| Royce & Associates | 6% | 5% | 4% | 3% | 3% | 4% | 4% | 7% | 10% | 10% | 11% | 11% | 11% | 12% | 12% | 13% | 13% | 13% | 13% | 12% |
| Renaissance Tech. Corp | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 1% | 1% | 0% | 6% | 17% | 22% | 21% | 15% | 13% | 15% | 15% |
| Invesco | 5% | 4% | 4% | 10% | 13% | 4% | 9% | 9% | 9% | 9% | 8% | 7% | 6% | 5% | 9% | 10% | 12% | 12% | 11% | 11% |
| Capital Group | 8% | 8% | 9% | 10% | 11% | 11% | 13% | 13% | 13% | 11% | 12% | 10% | 12% | 12% | 12% | 11% | 11% | 12% | 11% | 10% |
| Goldman Sachs | 0% | 0% | 0% | 2% | 0% | 6% | 6% | 6% | 6% | 7% | 8% | 11% | 11% | 14% | 13% | 12% | 9% | 9% | 9% | 8% |

**Table 4.** Panel regressions: top management pay as a function of own-firm and rival profits, market concentration, and common ownership.

This table presents the effects of product market differentiation (HHI) and common ownership (MHHID) on total compensation (TDC1) as described in equation (23). An industry is defined at the CRSP 4-digit SIC code. Column 1 presents the Aggarwal and Samwick (1999a) set-up – own and rival profits, and product market differentiation, and their interactions – complemented with industry and year fixed effects. Column 2 adds the measure of common ownership (MHHID) and the interactions with own and rival profits. Column 3 adds controls. Columns 4 and 5 run run specification 3 on the CEO and non-CEO subsample. Panel B reports the inverse compensation ratio test as described in equation (25): S is the change in the ratio of rival-firm pay-performance sensitivity over own pay-performance sensitivity (i.e. $\frac{\beta}{\alpha}$) relative to the cdf of common ownership (MHHID). All standard errors are clustered at the firm level.

| PANEL A | Dependent Variable: Top Management Pay | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Own * MHHID | | -0.117** | -0.0918** | -0.178 | -0.0823** |
| | | (-2.057) | (-2.145) | (-1.525) | (-2.509) |
| Rival * MHHID | | 0.148** | 0.106** | 0.244* | 0.108*** |
| | | (2.451) | (2.257) | (1.856) | (2.967) |
| MHHID | | 888.2*** | 99.80 | 467.1** | 41.90 |
| | | (9.007) | (1.404) | (2.503) | (0.742) |
| Own * HHI | 0.137*** | 0.0543 | -0.0604 | -0.132 | -0.0477 |
| | (4.473) | (1.117) | (-1.544) | (-1.214) | (-1.606) |
| Rival * HHI | -0.128*** | -0.0322 | 0.0676 | 0.181 | 0.0677* |
| | (-3.345) | (-0.568) | (1.516) | (1.456) | (1.948) |
| HHI | -74.42 | 484.1*** | -366.8*** | -638.6*** | -328.3*** |
| | (-0.815) | (4.535) | (-4.830) | (-3.251) | (-5.438) |
| Own | 0.226*** | 0.330*** | 0.230*** | 0.546*** | 0.183*** |
| | (15.43) | (6.043) | (5.472) | (4.847) | (5.736) |
| Rival | 0.325*** | 0.182*** | -0.0183 | -0.0755 | -0.0283 |
| | (18.65) | (3.089) | (-0.391) | (-0.581) | (-0.786) |
| Ceo | | | 2,237*** | | |
| | | | (79.32) | | |
| Log(Sales) | | | 784.4*** | 1,817*** | 604.5*** |
| | | | (44.56) | (42.23) | (44.84) |
| Volatility | | | 3,733*** | 6,604*** | 2,955*** |
| | | | (10.42) | (7.494) | (10.88) |
| Tenure | | | 35.91*** | -10.48 | 31.14*** |
| | | | (9.613) | (-0.979) | (10.91) |
| Observations | 192,110 | 192,110 | 183,133 | 33,053 | 150,080 |
| R-squared | 0.160 | 0.164 | 0.463 | 0.445 | 0.407 |
| Industry FE | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |

| PANEL B | | | | | |
|---|---|---|---|---|---|
| Hypothesis test at the median (F(HHI)=0.5 and F(MHHID)=0.5) | | | | | |
| Inverse Comp. Ratio Test | | 0.242*** | 0.147*** | 0.306** | 0.150*** |
| P-Value | | 0.006 | 0.008 | 0.041 | 0.001 |

**Table 5.** Panel regressions with alternative industry definitions.

This table shows robustness of the results from Table 4 across industry definitions. Column 1 is the reference specification (column 3 in Table 3). Column 2 refines the definition of the rival group as the size tertile within the 4-digit SIC code, as in Albuquerque (2009). Columns 3 and 4 use the alternative industry definition proposed by Hoberg and Phillips (2010) (HP) at the 400 level for the benchmark, and the size split specifications, respectively. Columns 5 and 6 present results at the more aggregated SIC3 and HP 300 levels. All specifications have industry and year fixed effects and a full set of controls. Panel B reports the inverse compensation ratio test as described in equation (25): S is the change in the ratio of rival-firm pay-performance sensitivity over own pay-performance sensitivity (i.e. $\frac{\beta}{\alpha}$) relative to the cdf of common ownership (MHHID). All standard errors are clustered at the firm level.

| PANEL A | Dependent Variable: Top Management Pay | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Own * MHHID | -0.0918** | -0.111*** | -0.0978** | -0.153*** | -0.0792** | -0.0800* |
| | (-2.145) | (-2.678) | (-2.140) | (-3.193) | (-2.066) | (-1.825) |
| Rival * MHHID | 0.106** | 0.0987** | 0.0181 | 0.0778 | 0.0204 | 0.00341 |
| | (2.257) | (2.346) | (0.324) | (1.413) | (0.446) | (0.0697) |
| MHHID | 99.80 | 366.7*** | 432.4*** | 619.9*** | 201.0*** | 418.2*** |
| | (1.404) | (5.676) | (5.791) | (9.431) | (3.070) | (5.870) |
| Own * HHI | -0.0604 | -0.0889** | -0.0122 | -0.0541 | -0.0141 | -0.0207 |
| | (-1.544) | (-2.266) | (-0.337) | (-1.421) | (-0.400) | (-0.545) |
| Rival * HHI | 0.0676 | 0.0687 | 0.00797 | 0.0575 | -0.0249 | 0.00427 |
| | (1.516) | (1.626) | (0.149) | (1.092) | (-0.545) | (0.0857) |
| HHI | -366.8*** | -212.8*** | 146.9* | 199.1*** | -324.5*** | 46.76 |
| | (-4.830) | (-3.175) | (1.895) | (2.980) | (-4.264) | (0.688) |
| Own | 0.230*** | 0.262*** | 0.214*** | 0.276*** | 0.203*** | 0.205*** |
| | (5.472) | (6.086) | (4.958) | (5.705) | (5.711) | (4.794) |
| Rival | -0.0183 | -0.0336 | 0.116** | 0.0399 | 0.0936** | 0.118** |
| | (-0.391) | (-0.751) | (2.110) | (0.682) | (2.117) | (2.427) |
| Ceo | 2,237*** | 2,236*** | 2,274*** | 2,275*** | 2,253*** | 2,271*** |
| | (79.32) | (79.29) | (77.24) | (77.31) | (80.84) | (77.34) |
| Log(Sales) | 784.4*** | 779.0*** | 779.7*** | 762.3*** | 771.3*** | 783.1*** |
| | (44.56) | (43.62) | (44.16) | (41.62) | (45.17) | (44.26) |
| Volatility | 3,733*** | 3,772*** | 3,691*** | 3,733*** | 3,690*** | 3,675*** |
| | (10.42) | (10.52) | (10.44) | (10.51) | (10.72) | (10.55) |
| Tenure | 35.91*** | 35.46*** | 32.87*** | 32.22*** | 35.09*** | 33.18*** |
| | (9.613) | (9.535) | (8.789) | (8.663) | (9.725) | (8.918) |
| Observations | 183,133 | 182,601 | 166,027 | 165,915 | 194,192 | 166,541 |
| R-squared | 0.463 | 0.464 | 0.458 | 0.459 | 0.463 | 0.458 |
| Industry Def | SIC4 | SIC4-Size | HP400 | HP400-Size | SIC3 | HP300 |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

| PANEL B | | | | | | |
|---|---|---|---|---|---|---|
| Hypothesis test at the median (F(HHI)=0.5 and F(MHHID)=0.5) | | | | | | |
| Inverse Comp. Ratio Test | 0.147*** | 0.133*** | 0.978 | 0.173*** | 0.066 | 0.067 |
| P-Value | 0.008 | 0.003 | 0.172 | 0.005 | 0.238 | 0.305 |

**Table 6. Panel A**. Panel-IV: First stage regressions.

This table presents the first stage of the IV analysis. Following the methodology in Anton and Polk (2014) we predict the values for MHHID and the interactions of MHHID with Own and Rival profits with the ratio of common ownership that comes from scandalous fund with respect to total common ownership as of September 2003 interacted with the respective profit measure. Columns 1 to 3 correspond to SIC4 and columns 4 to 6 to Hoberg and Phillips (2010) (HP) industry definitions, respectively. We include all controls present in the second stage. All standard errors are clustered at the firm level.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dep. Variables | MHHID | Own*MHHID | Rival*MHHID | MHHID | Own*MHHID | Rival*MHHID |
| ScandalRatio | -0.0618*** | 15.56 | -10.17 | 0.237*** | -26.98* | 0.366 |
| | (-8.263) | (1.131) | (-0.790) | -21.2 | (-1.731) | (0.0271) |
| MHHID03 | 0.407*** | -47.19*** | -43.30*** | 0.489*** | -38.96*** | -32.29*** |
| | (73.50) | (-4.633) | (-4.542) | (93.76) | (-5.354) | (-5.119) |
| Own * ScandalRatio | 1.87e-05*** | -0.0200** | 0.0806*** | -4.74e-05*** | -0.0666*** | -0.0539*** |
| | (3.879) | (-2.254) | (9.715) | (-5.468) | (-5.502) | (-5.146) |
| Own * MHHID03 | 8.88e-07 | 0.478*** | 0.0438*** | -5.97e-06 | 0.574*** | 0.00778 |
| | (0.258) | (75.46) | (7.382) | (-1.488) | (102.7) | (1.606) |
| Rival * ScandalRatio | 5.08e-06 | 0.0787*** | -0.0279*** | -4.47e-05*** | -0.0260* | -0.0201 |
| | (0.948) | (7.987) | (-3.024) | (-4.237) | (-1.766) | (-1.574) |
| Rival * MHHID03 | 3.76e-06 | 0.0298*** | 0.443*** | -1.91e-05*** | -0.00707 | 0.516*** |
| | (1.004) | (4.315) | (68.69) | (-3.943) | (-1.045) | (88.07) |
| Own * HHI | -5.68e-06* | -0.364*** | 0.0645*** | 8.49e-06*** | -0.265*** | 0.0636*** |
| | (-1.825) | (-63.65) | (12.04) | (2.576) | (-57.56) | (15.97) |
| Rival * HHI | 1.49e-05*** | 0.0706*** | -0.381*** | -1.80e-05*** | 0.0405*** | -0.363*** |
| | (4.253) | (10.93) | (-63.11) | (-4.256) | (6.852) | (-70.91) |
| HHI | -0.435*** | -58.99*** | -21.93** | -0.348*** | -35.36*** | -20.01*** |
| | (-82.70) | (-6.099) | (-2.422) | (-71.81) | (-5.239) | (-3.421) |
| Own | -2.00e-06 | 0.511*** | -0.0617*** | 1.06e-05** | 0.477*** | -0.0164*** |
| | (-0.539) | (75.00) | (-9.676) | (2.337) | (75.25) | (-2.980) |
| Rival | -8.42e-06** | -0.0505*** | 0.548*** | 2.84e-05*** | -0.00925 | 0.539*** |
| | (-2.036) | (-6.644) | (77.01) | (5.152) | (-1.202) | (80.76) |
| CEO | 0.00134 | 1.395 | 0.214 | -0.00225 | -2.958 | -1.279 |
| | (0.510) | (0.289) | (0.0474) | (-0.942) | (-0.888) | (-0.443) |
| Log(Sales) | 0.0212*** | 8.858*** | 8.523*** | 0.0266*** | 6.059*** | 3.138*** |
| | (24.99) | (5.692) | (5.850) | (32.22) | (5.264) | (3.145) |
| Volatility | -0.161*** | 127.7*** | 101.2*** | 0.00686 | -56.83** | 26.83 |
| | (-8.392) | (3.620) | (3.064) | (0.393) | (-2.334) | (1.271) |
| Tenure | -0.000178 | -0.117 | 0.0754 | 0.000940*** | 0.888*** | 0.724** |
| | (-0.671) | (-0.240) | (0.165) | (3.889) | (2.632) | (2.476) |
| Observations | 26,976 | 26,976 | 26,976 | 29,098 | 29,098 | 29,098 |
| R-squared | 0.654 | 0.959 | 0.954 | 0.652 | 0.981 | 0.977 |
| Industry Def | SIC4-Size | SIC4-Size | SIC4-Size | HP400-Size | HP400-Size | HP400-Size |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

**Table 6. Panel B**. Panel-IV: Underidentification and weak instrument tests.

This table shows results of tests for underidentification and weak identification for each endogenous regressor separately, using the method of Sanderson and Windmeijer (2016). We also report the Kleibergen and Paap (2006) Wald test for the full model. First-stage test statistics are cluster-robust.

| | Underidentification | | Weak Instr.) |
|---|---|---|---|
| Variable | SW Chi-Sq (4) | P-val | SW F(4, 1872) |
| MHHID | 583.78 | 0.000 | 145.43 |
| MHHID * Own | 156.85 | 0.000 | 39.08 |
| MHHID * Rival | 120.54 | 0.000 | 30.03 |

**Table 7.** Panel-IV: Second stage regressions.

This table uses the fitted values for MHHID and their interactions with Own and Rival profits from the previous table to estimate the impact of the 2003 mutual fund scandal on total compensation. Rivals are defined both with the four-digit CRSP SIC code (columns 1 and 2) and Hoberg and Phillips (2010) (HP) 400 index (columns 3 and 4), respectively. The result of interest is reported in Panel B: the inverse compensation ratio as described in equation (25). S is the change in the ratio of rival-firm pay-performance sensitivity over own pay-performance sensitivity (i.e. $\frac{\beta}{\alpha}$) relative to the cdf of common ownership (MHHID). All standard errors are clustered at the firm level.

| PANEL A | Dependent Variable: Top Management Pay | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Own * MHHID | -0.427** | -0.336** | -0.178 | -0.232 |
| | (-2.158) | (-2.126) | (-0.980) | (-1.576) |
| Rival * MHHID | 0.339 | 0.268 | 0.553* | 0.416* |
| | (1.356) | (1.346) | (1.836) | (1.853) |
| MHHID | 1,140*** | 874.5*** | 897.2*** | 829.5*** |
| | (3.878) | (3.720) | (3.644) | (4.189) |
| Own * HHI | -0.244 | -0.181 | -0.0955 | -0.132 |
| | (-1.592) | (-1.451) | (-0.658) | (-1.202) |
| Rival * HHI | 0.153 | 0.132 | 0.324 | 0.271 |
| | (0.762) | (0.835) | (1.350) | (1.509) |
| HHI | 416.8** | 308.3* | 591.0*** | 525.8*** |
| | (1.998) | (1.837) | (3.554) | (3.962) |
| Own | 0.582*** | 0.452*** | 0.331* | 0.354** |
| | (3.001) | (2.900) | (1.711) | (2.283) |
| Rival | -0.155 | -0.129 | -0.320 | -0.235 |
| | (-0.617) | (-0.643) | (-0.991) | (-0.979) |
| Ceo | 2,362*** | | 2,402*** | |
| | (52.63) | | (55.12) | |
| Log(Sales) | 762.1*** | 590.6*** | 717.4*** | 543.9*** |
| | (26.80) | (26.13) | (23.86) | (23.03) |
| Volatility | 3,939*** | 3,110*** | 3,641*** | 2,882*** |
| | (8.205) | (7.970) | (7.424) | (7.200) |
| Tenure | 28.24*** | 29.64*** | 27.94*** | 30.23*** |
| | (4.976) | (6.634) | (5.163) | (7.076) |
| Observations | 24,989 | 20,416 | 26,937 | 22,001 |
| R-squared | 0.511 | 0.461 | 0.513 | 0.461 |
| Industry Def | SIC4-Size | SIC4-Size | HP400-Size | HP400-Size |
| Year FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |

| PANEL B | | | | |
|---|---|---|---|---|
| Hypothesis test at the median (F(HHI)=0.5 and F(MHHID)=0.5) | | | | |
| Inverse Comp. Ratio Test | 0.497** | 0.392** | 0.661** | 0.561*** |
| P-Value | 0.044 | 0.044 | 0.023 | 0.005 |

# Internet Appendix to: Common Ownership, Competition, and Top Management Incentives

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**Abstract**

This internet appendix provides model extensions and generalization and additional empirical results for the paper "Common Ownership, Competition, and Top Management Incentives."

# Appendix A: Additional Theoretical Results

## A Moral Hazard, Risk Aversion, and Multi-tasking

The following model extension has the dual purpose of showing the robustness of the key result, and of generating an additional, more nuanced testable prediction. Consider the following multi-tasking moral hazard model. Two firms, each employing a risk-averse manager with exponential utility and a reservation wage of 0 who receives a linear compensation scheme given by

$$w_i = k_i + \alpha_i \pi_i + \beta_i \pi_j, \tag{1}$$

where the profits of firm $i$ are given by

$$\pi_i = e_{1,i} + h e_{2,j} + \nu, \tag{2}$$

and where $\nu$ is a common shock that is normally distributed with mean 0 and variance $\sigma^2$.

Each manager $i$ can exert two types of effort: productive effort $e_{1,i}$ which increases own firm profits, or competitive effort $e_{2,i}$ which influences the rival firm's profits. The impact of competitive effort can either be positive or negative depending on the sign of $h$. If $h = 0$, the two firms are essentially two separate monopolists. Thus, competitive effort $e_{2,i}$ can be thought of as a reduced-form way of modeling competitive product market interaction between the two firms. Note that competitive effort $e_{2,i}$ can take both positive and negative values. For simplicity, we assume that the cost for both types of effort is quadratic.

There are two owners, A and B. As before, we assume that they are symmetric such that A owns a share $x \geq 1/2$ of firm 1 and $1 - x$ of firm 2, and B owns $1 - x$ of firm 1 and $x$ of firm 2. Each majority owner sets an incentive contract $(k_i, \alpha_i, \beta_i)$ for her manager $i$ such that it maximizes the profit shares of the owner at both firms subject to individual rationality and incentive compatibility constraints.

The incentive compatibility constraints resulting from the agent $i$'s wage bill given by equation (1) yield the optimal effort levels for both types of effort:

$$e_{1,i} = \alpha_i \quad \text{and} \quad e_{2,i} = h\beta_i. \tag{3}$$

We can rewrite the manager's utility in terms of his certainty equivalent. After substituting for the binding individual rationality and the two incentive compatibility constraints in (3), the maximization problem of the majority owner of firm $i$ becomes

$$\max_{\alpha_i,\beta_i} \quad x[\alpha_i + h\alpha_j - \frac{1}{2}\alpha_i^2 - \frac{1}{2}(h\beta_i)^2 - \frac{r}{2}(\alpha_i+\beta_i)^2\sigma^2]$$
$$+(1-x)[\alpha_j + h\alpha_i - \frac{1}{2}\alpha_j^2 - \frac{1}{2}(h\beta_j)^2 - \frac{r}{2}(\alpha_j+\beta_j)^2\sigma^2]. \tag{4}$$

Thus, the first order conditions for $\alpha_i$ and $\beta_i$ are given by

$$1 - \alpha_i - r\sigma^2(\alpha_i+\beta_i)^2 = 0 \tag{5}$$
$$x(-h^2\beta_i^2 - r\sigma^2(\alpha_i+\beta_i)^2) + xh^2 = 0. \tag{6}$$

Because the two firms are symmetric we can drop the $i$ subscript. Solving this system of equations yields the optimal incentive slopes:

$$\alpha^* = 1 - \frac{1}{x}\frac{h^2r\sigma^2}{h^2r\sigma^2 + h^2 + r\sigma^2} \tag{7}$$
$$\beta^* = -1 + \frac{1}{x}\frac{h^2r\sigma^2 + h^2}{h^2r\sigma^2 + h^2 + r\sigma^2}. \tag{8}$$

It is straightforward to show that $0 < \alpha^* < 1$ and $\alpha^* > \beta^*$. Furthermore, in terms of absolute value, the incentives on own profits are always stronger than on rival profits; that is, $\alpha^* > |\beta^*|$. Most importantly, this model also yields our main prediction that the own-profit incentive slope

$\alpha^*$ is decreasing while the rival-profit incentive slope $\beta^*$ is increasing in the degree of common ownership $1 - x$.

**Proposition 2.** *The optimal incentive slope on own profits* $\alpha^*$ *is decreasing and the optimal incentive slope on rival profits* $\beta^*$ *is increasing in* $1 - x$ *for* $1/2 \leq x \leq 1$.

In addition, the model has all the natural features of moral hazard with linear contracts. The optimal incentive slope for $\alpha^*$ is distorted away from the first-best of 1 because of two factors: the manager's risk aversion $r$ and the impact of competitive effort on the other firm $h$. When the manager has no influence on the profits of the other firm ($h = 0$), the first best ($\alpha^* = 1$) can be achieved through a strong RPE by setting $\beta^* = -1$, thereby completely filtering out all noise $\nu$ in the firm's profits. The higher the impact on the other firm $h$, the degree of risk aversion $r$, and the variance $\sigma^2$, the more strongly the two incentive slopes are distorted away from the first best.

The model also allows us to analytically solve for the optimal level of base pay $k^*$ by substituting the agent's equilibrium competitive efforts into the binding IR constraint of the manager. In particular, the optimal $k^*$ is given by

$$k^* = \frac{1}{2}(\alpha^*)^2 + \frac{1}{2}h^2(\beta^*)^2 + \frac{1}{2}r\sigma^2(\alpha^* + \beta^*)^2 - (\alpha^* + \beta*)(\alpha^* + h^2\beta^*). \tag{9}$$

Substituting the optimal values of $\alpha^*$ and $\beta^*$ and differentiating with respect to $x$ yields the following predicted effect of common ownership on managerial base pay.

**Proposition 3.** *The optimal base pay* $k^*$ *is increasing in* $1 - x$ *for* $1/2 \leq x \leq 1$ *if* $|h|$ *and* $r$ *are sufficiently large.*

In other words, unconditional base pay increases in the degree of common ownership. The owner trades off two conflicting aims of RPE: providing risk insurance from the common shock to the manager and incentivizing managerial choices that affect the rival firm. If the manager has no influence on the profits of the other firm (e.g., $h = 0$), then the second consideration is absent. Hence, it is always optimal for the owner to use strong RPE by setting $\beta^* = -\alpha^*$, thereby completely filtering out all the common noise in the firm's profits and providing perfect insurance to the manager. However, if the manager's actions also affect the rival firm, it will no longer be optimal to set $\beta^* = -\alpha^*$ because doing so would lead to excessively competitive behavior on behalf of the manager. But this incomplete filtering of common noise now exposes the risk-averse manager to some compensation risk. Given that the manager is risk-averse, meeting his outside option now requires paying a higher base wage $k^*$.

Finally, note that the model also predicts that the equilibrium incentive slope on rival-firm profits $\beta^*$ can be positive for sufficiently high levels of common ownership. In particular, $\beta^* > 0$ if and only if $x < \frac{h^2 r\sigma^2 + h^2}{h^2 r\sigma^2 + h^2 + r\sigma^2}$.

## B Moral Hazard, Risk Aversion, and Product Market Competition

Our baseline model abstracts from managerial risk aversion and the moral hazard problem that exists between shareholders and managers. Consider therefore the following change to our Bertrand product market competition model to incorporate an effort choice, a disutility of effort, a common performance shock, and risk aversion. Each agent's compensation contract is still given by

$$w_i = k_i + \alpha_i \pi_i + \beta_i \pi_j, \tag{10}$$

where

$$\pi_i = (p_i - c)(B - dp_i + ep_j) + tm_i + \nu. \tag{11}$$

The profit function now includes the agent's effort $m_i$, the marginal return to effort $t$, and a common shock $\nu$ that is normally distributed with mean 0 and variance $\sigma^2$.

The agent has exponential utility and her certainty equivalent is

$$u_i = w_i - \frac{s}{2}m_i^2 - \frac{r}{2}(\alpha_i + \beta_i)^2\sigma^2, \tag{12}$$

where $s$ is the marginal cost of effort and $r$ is the agent's risk aversion.

Rewriting the binding agent's individual rationality constraint in certainty equivalent terms yields the agent's maximization problem:

$$\begin{aligned}\max_{m_i,p_i} \quad & \alpha_i(p_i - c)(B - dp_i + ep_j + tm_i) + \beta_i(p_j - c)(A - dp_j + ep_i + tm_j) \\ & - \frac{s}{2}m_i^2 - \frac{r}{2}(\alpha_i + \beta_i)^2\sigma^2. \end{aligned} \tag{13}$$

With this additively separate setup, the agents' optimal price choices remain the same functions as in our baseline model given by equations (9) and (10) of the main text. In addition, the agent's optimal effort is

$$m_i^* = \frac{t}{s}\alpha_i, \tag{14}$$

which is unaffected by the price choice.

After substituting for the manager's binding individual rationality constraint the maximization problem of the majority owner of firm $i$ becomes

$$\begin{aligned}\max_{\alpha_i,\beta_i} \quad & x[(p_i - c)(B - dp_i + ep_j) + tm_i - \frac{s}{2}m_i^2 - \frac{r}{2}(\alpha_i + \beta_i)^2\sigma^2] \\ & +(1-x)[(p_j - c)(B - dp_j + ep_i) + tm_j - \frac{s}{2}m_j^2 - \frac{r}{2}(\alpha_j + \beta_j)^2\sigma^2]. \end{aligned} \tag{15}$$

Generally solving the system of equations that results from the first order conditions of the two owners is not analytically feasible, even for the symmetric equilibrium. However, we can solve the system numerically to generate comparative statics. Consider first the following extreme case. When there is no product substitution $a = 0$ (hence $e = 0$), each firm is a separate monopolist. In the case of completely separate ownership ($x = 1$), the unique optimal contract is $\{\alpha^* = 1, \beta^* = -1\}$, which is an RPE contract that completely filters out the common shock $\nu$. That is, in the absence of strategic considerations, the optimal contract involves a large negative incentive slope $\beta^*$. More generally, for the case of some product substitutability $a > 0$, the optimal contracts will put positive weight on both the own and the rival firms, $\alpha^* \in (0, 1]$, $\beta^* \in (0, 1)$.

From our previous analysis, we know that as we move to more common ownership increases, the optimal $\beta^*$ increases because the owners induce a softening of competition through the incentive contracts. This change in $\beta^*$ came at no cost in our baseline model, but in the augmented model with moral hazard and risk aversion, it imposes more risk on the agent because the optimal contract no longer completely filters out the common shock $\nu$. The manager, however, has to be compensated for this increase in risk, and therefore the base pay $k^*$ has to be higher to induce him to accept the contract. The following proposition formalizes this intuition and yields an additional testable implication. Note that we are unable to solve the system of equations analytically, but the following proposition holds for all of our numerical simulations if product substitutability and risk aversion are sufficiently large.

**Proposition 4.** *The optimal base pay $k^*$ is increasing in $1 - x$ for $1/2 \leq x \leq 1$ if $a$ and $r$ are sufficiently large.*

A limitation of our analysis is that it leaves out managerial turnover, which delivers a further rationale for higher base pay under common ownership: common shareholders can fire managers that don't act in their interest. The managers' desire to retain her job is strengthened when the base pay is higher. Higher base pay can thus be used to align managerial incentives with the most powerful shareholders. Making this point explicit is outside the scope of our paper, but is addressed in Azar (2016).

## C Managerial Conflict of Interest

Our baseline model is similar to the setup in Fershtman and Judd (1987), Sklivas (1987), and Aggarwal and Samwick (1999). It assumes that in the absence of explicit incentives in the form of $\alpha_i$ and $\beta_i$, the manager of firm $i$ is completely indifferent when it comes to making strategic decisions. In fact, if he were to receive incentives $\alpha_i = \beta_i = 0$ he would just make random choices. However, as soon as the manager is given any non-zero $\alpha_i$, the compensation ratio completely pins down his optimal output or price choice. Thus, unlike in our extensions that consider moral hazard and managerial effort choice only a minimal conflict of interest exists between the manager and the owner of the firm.

Consider instead a more realistic model of managerial decision-making with a different conflict of interest in which each manager also derives private benefits from maximizing his own firm's profits. These private benefits could arise from managerial perks or career concerns. Denote the strength of these private benefits by $P$. Thus, manager $i$'s utility function is now given by

$$U_i = P\pi_i + w_i = P\pi_i + k_i + \alpha_i\pi_i + \beta_i\pi_j. \tag{16}$$

When deciding how to set incentives, the majority owner of firm $i$ now has to take into account that manager $i$ is motivated by private benefits. However, the only change in the model's result that these private benefits induce is that the owner now has to set the adjusted inverse compensation ratio $\frac{\beta_i}{P+\alpha_i}$ correctly. Because $P$ is just a constant our main result regarding the unambiguous effect of common ownership on the inverse compensation ratio remains unchanged.

# Appendix B: Additional Empirical Results

## Appendix Tables

**Table A. I.** Panel regressions with Wealth-performance sensitivities and common ownership.

This table reports the effect of common ownership on wealth-performance sensitivity, whereas wealth-performance sensitivity measures are taken directly from Edmans et al. (2009) and cover the years 1999 until 2003. Columns 1 to 4 report the regressions using the scaled wealth-performance sensitivity (lnB1) as the dependent variable, with common ownership (MHHID) as the explanatory variable of interest, and various combinations of HHI and log of sales as controls. Columns 5 and 6 show the robustness of the results to the alternative B2 (Jensen and Murphy, 1990) and B3 (Hall and Liebman, 1998) definitions of wealth-performance sensitivities, also taken from Edmans et al. (2009).

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dep. variable | ln(B1) | ln(B1) | ln(B1) | ln(B1) | ln(B2) | ln(B3) |
| MHHID | -0.372*** | -0.598*** | -0.367*** | -0.598*** | -0.447*** | -0.444*** |
| | (-4.117) | (-5.936) | (-3.989) | (-5.496) | (-4.414) | (-4.129) |
| HHI | | -0.338*** | | -0.337*** | -0.197* | -0.436*** |
| | | (-3.331) | | (-3.139) | (-1.957) | (-3.979) |
| Log(Sale) | | | -0.00831 | -0.000520 | -0.480*** | 0.414*** |
| | | | (-0.488) | (-0.0295) | (-29.18) | (24.37) |
| Observations | 26,430 | 26,430 | 26,430 | 26,430 | 26,430 | 26,430 |
| R-squared | 0.075 | 0.076 | 0.075 | 0.076 | 0.300 | 0.174 |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

**Table A. II.** Panel regressions with alternative common ownership measure.

This table presents specifications similar to those in Table 4, whereas the common ownership measure varies. Instead of using actual market shares to compute the O'Brien and Salop (2000) MHHID, we use the ratio of one divided by the number of firms in the industry. Standard errors are clustered at the firm level.

| | (1) SIC4-Size | (2) SIC4-Size | (3) SIC4-Size | (4) SIC4-Size | (5) HP4-Size | (6) HP4-Size | (7) HP4-Size | (8) HP4-Size |
|---|---|---|---|---|---|---|---|---|
| Own * MHHID | -0.125*** | -0.0767** | -0.223** | -0.0596** | -0.110** | -0.106*** | -0.197* | -0.0820** |
| | (-2.705) | (-2.109) | (-2.166) | (-2.115) | (-2.110) | (-2.579) | (-1.706) | (-2.564) |
| Rival * MHHID | 0.137*** | 0.0912** | 0.181* | 0.0848*** | 0.109* | 0.0543 | 0.248* | 0.0651* |
| | (2.692) | (2.424) | (1.741) | (2.770) | (1.744) | (1.098) | (1.755) | (1.650) |
| MHHID | 1,352*** | 394.9*** | 963.2*** | 297.8*** | 1,663*** | 424.3*** | 1,192*** | 318.3*** |
| | (17.36) | (7.193) | (6.485) | (6.939) | (21.25) | (7.185) | (7.754) | (6.795) |
| Own * HHI | 0.0427 | -0.0471 | -0.126 | -0.0281 | 0.0721* | 0.00549 | 0.0121 | 0.00235 |
| | (1.260) | (-1.621) | (-1.539) | (-1.273) | (1.696) | (0.179) | (0.126) | (0.0951) |
| Rival * HHI | -0.0538 | 0.0392 | 0.127 | 0.0348 | -0.117* | 0.0176 | -0.00861 | 0.0265 |
| | (-1.239) | (1.190) | (1.404) | (1.334) | (-1.925) | (0.395) | (-0.0657) | (0.743) |
| HHI | 306.4*** | -313.2*** | -729.9*** | -263.3*** | 750.9*** | -11.51 | -48.74 | -13.08 |
| | (3.762) | (-5.451) | (-4.904) | (-5.772) | (8.766) | (-0.188) | (-0.297) | (-0.270) |
| Own | 0.345*** | 0.222*** | 0.596*** | 0.166*** | 0.268*** | 0.214*** | 0.481*** | 0.163*** |
| | (8.157) | (6.472) | (6.265) | (6.335) | (5.702) | (5.842) | (4.635) | (5.717) |
| Rival | 0.153*** | -0.0181 | -0.0620 | -0.0178 | 0.348*** | 0.0762 | 0.105 | 0.0472 |
| | (3.143) | (-0.488) | (-0.613) | (-0.596) | (5.677) | (1.585) | (0.774) | (1.236) |
| Ceo | | 2,236*** | | | | 2,275*** | | |
| | | (79.29) | | | | (77.29) | | |
| Log(Sale) | | 779.2*** | 1,810*** | 600.3*** | | 774.4*** | 1,815*** | 592.5*** |
| | | (44.28) | (42.15) | (44.69) | | (42.77) | (41.24) | (42.86) |
| Volatility | | 3,759*** | 6,622*** | 2,981*** | | 3,740*** | 6,573*** | 2,980*** |
| | | (10.45) | (7.481) | (10.93) | | (10.48) | (7.450) | (10.99) |
| Tenure | | 35.44*** | -11.29 | 30.76*** | | 32.52*** | -22.20** | 30.26*** |
| | | (9.535) | (-1.057) | (10.86) | | (8.717) | (-2.092) | (10.60) |
| Observations | 191,557 | 182,601 | 32,952 | 149,649 | 165,915 | 165,915 | 29,986 | 135,929 |
| R-squared | 0.169 | 0.464 | 0.446 | 0.408 | 0.173 | 0.458 | 0.444 | 0.399 |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

PANEL B

| Hypothesis test at the median: F(HHI)=0.5 and F(MHHID)=0.5 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Inverse Comp Ratio | 0.217*** | 0.114*** | 0.230** | 0.105*** | 0.261*** | 0.127** | 0.362** | 0.127*** |
| P-Value | 0.001 | 0.004 | 0.033 | 0.002 | 0.010 | 0.029 | 0.029 | 0.008 |

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