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Abstract

Standard corporate finance theories assume the absence of strategic product market interactions or that shareholders don't diversify across industry rivals; the optimal incentive contract features pay-for-performance relative to industry peers. Empirical evidence, by contrast, indicates managers are rewarded for rivals' performance as well as for their own. We propose common ownership of natural competitors by the same investors as an explanation. We show theoretically and empirically that executives are paid less for own performance and more for rivals' performance when the industry is more commonly owned. The growth of common ownership also helps explain the increase in CEO pay over the past decades.

JEL Codes: G30, G32, D21, J31, J41

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I Introduction

The level and structure of top management pay has been the subject of a fiery public debate for a long time, most recently by all major presidential candidates. Corresponding to the public interest, a large academic literature has examined its determinants. Much of it has focused on how board characteristics determine the extent to which pay packages are competitive, as opposed to reflective of unresolved agency problems.[1] More recently, the public debate has moved to questioning the role of many firms' most powerful shareholders in bringing about, or at least condoning, what some perceive as "excessive" compensation packages. In particular, a small set of very large mutual fund companies find themselves asked why they systematically vote "yes" on compensation packages that guarantee high levels of pay but are only weakly related to the (relative) performance of the firm executives run.[2] Performance-insensitive pay not only defies common sense, but also the established economic theory on optimal incentive provision. Why then do the largest and most powerful shareholders of many firms support such pay packages?

Deepening the puzzle, the approval of the seemingly sub-optimal contracts does not seem to be due to inattention. To the contrary, BlackRock (BLK), the largest shareholder of about one fifth of all American corporations (Davis, 2013), recognizes that "executive compensation that is disconnected from company performance is a symptom of broader governance failures," which it is committed to rectify. Indeed, almost half of the hundreds of engagement meetings the firm conducts every year feature discussions about executive compensation (Melby, 2016).

A perceived lack of power, i.e., inability to influence pay packages, does not seem be an obstacle either. BLK's leaders claim to have power to influence firm behavior far beyond pay structure. A quick Google search brings up Larry Fink saying "We can tell a company to fire 5000 employees tomorrow..." (Rolnik, 2016) while Reuters reports "When BlackRock calls, CEOs listen

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

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

and do deals" (Hunnicutt, 2016), etc. To bring about change, "being able to talk to boards" in private engagement meetings "is [BLK's] most important tool," and more powerful than voting alone (BlackRock, 2015; Booraem, 2014). Indeed, "we only vote against management when direct engagement has failed" (BlackRock, 2016), or, more colorfully: "engagement is the carrot, voting is the stick." Judging from the voting patterns on pay, shareholders seem to think that the carrot is effective.[3] Given these shareholders' attention to executive pay and their apparent power to affect it, it seems perplexing to many observers why they "wield [their] outsized stick like a wet noodle" (Morgenson, 2016) and rubber-stamp (if not encourage) compensation contracts that contradict fundamental predictions of incentive theory.

The present paper provides a rationale for why large diversified managers should indeed support pay packages that promise high unconditional salaries that are less related to firm performance and more related to aggregate performance. Our explanation combines common ownership of firms by an overlapping set of investors and imperfect product market competition. In theory, "common shareholders," including widely diversified asset managers such as BLK and Vanguard, will aim to maximize the value of their entire stock portfolio, rather than the performance of individual firms within that portfolio. (The reason is that mutual fund families earn money by charging their investors a fixed percentage of total assets under management.) They should therefore optimally structure executive pay such that managers have weakened incentives to compete aggressively against their industry rivals, thereby competing away industry profits.

This explanation also generates testable predictions about the cross-sectional variation in pay-performance sensitivities and the level of pay: increasing common ownership concentration should lead to reduced pay-performance sensitivity, less relative performance evaluation, and higher unconditional CEO pay. These predictions find strong support in the data. Our findings support the notion that broadly diversified investors do not challenge performance-insensitive compensation

[3]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 BLK, 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).

packages simply because letting them pass is in their economic interest.

Our analysis departs from but also nests standard models of optimal incentive provision in principal-agent problems (e.g., Holmstrom (1979)). Such models typically assume that shareholders unanimously want the manager to maximize the firm's own value. The question they address is how to most inexpensively incentivize the manager to act in line with the shareholders' interests. 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, but to filter out shocks that affect the entire industry and that the manager is unable to influence (Holmstrom, 1982). The clarity of this theoretical prediction contrasts with mixed empirical results in its support, discussed in Appendix A.

The theoretical part of this paper generalizes this model in two ways. First, we allow for the possibility that firms have market power and are 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. Second, 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 large stakes in the firm's competitors, shareholders do not want to incentivize managers to compete aggressively (e.g., to engage in price wars to increase market share). Instead, they choose to 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' profits. 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. The reason is that common ownership makes *not* benchmarking pay packages against aggregate industry fluctuations opportune, 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, as a novel contribution of our paper is to document in how many firms and in which fraction of firms a particular investor is among the top shareholders. For example, 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 than traditional concentration indexes that counterfactually assume completely separate ownership.

We then test the model's qualitative predictions.[4] First, we run panel regressions of executive pay on the firm's performance, rival firms' performance, a measure of market concentration (HHI), the common ownership density of the industry (MHHID), and interactions of profit and concentration 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, the pay-performance sensitivity also decreases with

[4]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). It is, however, not a structural model.

common ownership when pay is measured to include accumulated stock and option compensation as proposed by Edmans et al. (2012). Importantly, 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.

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 from the mutual fund trading scandal exploited previously by Anton and Polk (2014).[5] The results corroborate the findings from the panel regressions: executives are less incentivized to compete aggressively when the industry becomes more commonly owned.

We therefore argue for the likely existence of a causal effect of common ownership on the structure of incentive contracts. Although we also provided anecdotal evidence that large shareholders put much effort and thought into questions of executive compensation, our empirical analysis does not prove that observed compensation structures are the result of a conscious effort on behalf of asset managers to solve a maximization problem similar to the one we propose in the theoretical part of the paper. As elsewhere in economics, the "as-if" theory merely helps us understand the empirical patterns. In particular, our results are consistent with the benign interpretation that large mutual funds are "lazy owners" (Economist, 2015) that do nothing, except crowding out or voting against activist investors who would otherwise implement more relative performance evaluation and lower unconditional pay. Schmalz (2015) discusses a potential occurrence of such an event. Having lazy owners may simply allow management to live a quiet life (Bertrand and Mullainathan, 2003) with flat incentives, high profit margins, and little competition. Our paper does not attempt to distinguish between a causal effect of large diversified mutual funds being the largest owners, or its flip side – an effect of undiversified investors *not* being the largest owners.

[5]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.

Such a difference in interpretation does not affect the debate over whether there is a causal effect of large shareholders being common owners on managerial incentives, nor does it affect most policy implications. The conclusion section provides ideas on how regulators could potentially distinguish between these interpretations, along with a discussion of broader implications of our findings for financial economics.

II Model and Hypothesis Development

A Setup

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

A1 Product Market Competition

Two firms, labeled 1 and 2, engage in differentiated Cournot (Bertrand) competition. The model has two stages. At stage 1, the owners (she) of the firms write contracts with the managers (he), and 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.[6]

[6] 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.

The firms have symmetric marginal costs c and the profits of firm i are therefore given by

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

A2 Managers

Two risk-neutral managers, 1 and 2, set the quantity (price) for their respective firm. 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:

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

We assume that the majority owner of firm i chooses the contract for manager i. The contract is then revealed to both managers, and the managers choose quantities (prices). In this setup α_i is the incentive slope on own firm profits, β_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 $w_i^{'}$.

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 α_i and β_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 section C, we extend our model to allow for RPE due to managerial risk aversion. Finally, w_i is irrelevant in the maximization problem 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. Each majority owner sets an incentive contract (k_i, α_i, β_i) for her manager i such that it maximizes the profit shares of the owner at both firms. That is, the incentive contract for manager i internalizes 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 ($x = 1$) and equal ownership ($x = 1/2$).

B1 Separate Ownership ($x = 1$)

Under completely separate ownership ($x = 1$), 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. 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 relative 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 ($x = 1/2$)

Under equal ownership ($x = 1/2$), 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 β_i^* in the two extreme cases of ownership, it is easy to see that β_i^* increases under *both* forms of competition when moving to perfectly common ownership. Under Bertrand competition, it increases from $\alpha_i^* \frac{e}{2d-e} < \alpha_i^*$ to α_i^*, whereas under Cournot competition, it increases from $-\alpha_i^* \frac{a}{2b+a} < \alpha_i^*$ to α_i^*. Thus, the sign of the change in β_i^* is always positive, and hence we have an *unambiguous* prediction for how common ownership should change managerial incentives.[7] 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.

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 β_i or decreasing α_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.[8] 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

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

[8] 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.

increases the inverse compensation ratio. Thus, only the combination of common ownership and any form of strategic interaction is crucial to the existence of an effect on managerial incentives.

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 appendix, we also present two additional closely related contracting models that also incorporate managerial effort choice amid disutility of effort, risk aversion, and a common shock to firm profits.[9] Most importantly, in both models, our central prediction that common ownership increases 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 competitive investments) the profits of the rival firm. In addition to making the same prediction about the effect of common ownership on the optimal inverse compensation ratio $\frac{\beta^*}{\alpha^*}$, the model also separately ties down the optimal levels of the incentive slopes α^* and β^*. In particular, it predicts that α^* is decreasing and β^* is increasing in the degree of common ownership. (Our 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 these claims more formally:

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

Proof. See appendix. □

Second, in both the multi-tasking model as well as our baseline product market competition

[9] All of our analysis is also robust to a change in assumptions such 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. However, they neither change the predictions of our baseline model nor those of our extended models.

model (augmented by managerial effort, disutility of effort, risk aversion, and a common shock), an increase in common ownership increases the level of base pay k^*. Note that, as before, these predictions hold market shares constant; we will do the same in the empirical implementation.

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 appendix. □

In other words, unconditional base pay increases in the degree of common ownership. The intuition is as follows. In both of these models with risk aversion and a common shock, 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., 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., low prices) on behalf of the manager. However, an incentive scheme where $\beta^* > -\alpha^*$ 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. We now take these predictions to the data.

III Data

The model yields testable implications for the relationship between common ownership and the pay-performance sensitivity in executive compensation at the industry level. To test these predictions, we need measures of executive compensation, performance data, data on 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

This paper aims to answer to which extent common ownership concentration in an industry affects managerial incentives. To that end, we need to measure common ownership concentration. This endeavor is substantially more complicated in the empirical analysis than in theory, because there are typically more than two firms in an industry, and that different types of shareholders exist that hold a variety of different portfolios. Fortunately, the existing literature provides a candidate measure of common ownership concentration that stands up to these challenges.

We measure common ownership concentration with the *MHHI delta* (henceforth *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 firms value; this case obtains when all shareholders have their entire wealth invested in the same 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 γ_{ij} is the control share of firm j held by owner i, and β_{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, plus the profits of the other firms in the industry – to the extent that these 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 the resulting 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 the special case of separate ownership predicts $MHHI = HHI$ as a valid measure of market concentration.

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

where s_j is the market share of firm j, and the final terms 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 whether common ownership concentration in an industry relates to managerial incentives is potentially informative about the objective function of the firm.

B Data Description

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. Summary statistics about pay level, standard deviation, and distribution are given in Table 1 Panel A. Total compensation (TDC1) includes salary, bonus, stock and option grants, and any other payouts. 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 firm's increase in 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 firm's last-period market value. This measure has at least two advantages in addition to comparability to the literature. One is that market values are what matters to shareholders. Second, when markets are reasonably efficient, market values are more informative than accounting profits. Table 1 Panel A reports summary statistics about own and rival performance, sales, and volatility.

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 don't directly exert a significant influence on firm management. Inspection of proxy statements of all firms in particular industries, as performed by the previous literature (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 holdings of more than 23% of the top five institutional owners. Common ownership is mainly determined by the latter, and including or discarding the information on Bill Gates has little 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.[10] Common ownership summary statistics are discussed below.

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 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.[11]

[10] 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.

[11] See Flaherty and Kerber (2016) for an example and a brief discussion of potential legal consequences.

Industry Definitions. Regarding the definition of markets and industries, we again start with the benchmark provided by the existing corporate finance literature (i.e., Aggarwal and Samwick (1999a)), and then offer several refinements. Our baseline specifications define industries by four-digit SIC codes. Compustat North America provides sales, with which we construct the industry-year level HHI indices based on sales. 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 that the variation used decreases. We then provide robustness 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 relative performance evaluation (RPE) easier in the data. Hence, not size-splitting industries could lead to false positive support for our explanation, which disfavors RPE. Therefore, to be conservative from the perspective of finding support for our explanation, we also provide results that size-split industries, both defined by SIC codes and HP.

Despite our efforts at pushing the incentive literature's boundary on industry definitions, none of the industry definitions we employ is perfect. In general, the assumption that an industry corresponds to a market in a way that precisely maps to theory deviates from reality, no matter whether CRSP-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 to public firms.

C Common Ownership Across Industries and Over Time

Our sample goes 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, ownership concentration is about a quarter as large as product market concentration. However, these economy-wide summary statistics partly 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.

The variation in ownership concentration is not limited to the cross-section. Figure I shows that the increase in MHHID for the average four-digit SIC code industry in various sectors has been significant 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 already 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. As an example, 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. Indeed, Manufacturing and finance saw particularly large increases in ownership concentration while product market concentration remained essentially flat.

Figure II also illustrates 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. Even larger magnitudes have been reported with more precise 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 overall 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, that is, roughly the 2,000 largest publicly traded firms in the U.S.. Vanguard follows very close behind.

Although the industry cross-section of ownership concentration already speaks to the important role that large mutual funds play, the time series is perhaps even more instructive. 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, both BlackRock and Vanguard were among the top ten shareholders in almost no firms, they were among the top ten in almost 70 percent 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, for which large asset managers typically don't hold large blocks of shares.

IV 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 own-performance compensation and relative performance evaluation are affected by common ownership under imperfect competition. A basic equation that allows us to define 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 perfomance, and r refers to rivals' firm performance. α_{ij} is the pay-for-performance sensitivity, and β_{ij} is the sensitivity of manager i's pay ω_{ij} to firm j's rivals' performance.

Aggarwal and Samwick (1999a) are interested in the question how α_{ij} and β_{ij} depend on product market concentration. They hence extend this equation to

$$\begin{aligned} \omega_{ij} &= k_i + \alpha_1 \pi_j^o + \alpha_2 \pi_j^o F(HHI_j) + \\ &+ \beta_1 \pi_j^r + \beta_2 \pi_{jt}^r F(HHI_j) + \\ &+ \gamma_1 F(HHI_j) + \gamma_3 CEO_{ij} + \varepsilon_{ij}, \end{aligned} \tag{22}$$

where $F(HHI)$ is the industry's concentration rank, and take a particular interest in the coefficients α_2 and β_2. By contrast, the present paper investigates if common ownership concentration ($MHHID$), obtained from the generalized measure of market concentration $MHHI$ introduced above, has a significant effect on the incentive slopes α and β, respectively. Moreover, we employ panel regressions, i.e., use both cross-sectional and time-series variation. We hence further extend the equation,

$$\begin{aligned} \omega_{ijt} &= k_i + \alpha_1 \pi_{jt}^o + \alpha_2 \pi_{jt}^o F(HHI_{jt}) + \alpha_3 \pi_{jt}^o F(MHHID_{jt}) + \\ &+ \beta_1 \pi_{jt}^r + \beta_2 \pi_{jt}^r F(HHI_{jt}) + \beta_3 \pi_{jt}^r F(MHHID_{jt}) + \\ &+ \gamma_1 F(HHI_{jt}) + \gamma_2 F(MHHID_{jt}) + \gamma_3 CEO_{ijt} + \varepsilon_{ijt} \end{aligned} \tag{23}$$

where our interest is chiefly in the coefficients α_3 and β_3 to test Proposition 1, and in coefficient γ_2 to test Proposition 2.

In addition, following the literature, we 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, but 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 the effect of such a variable, 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 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. A specification that includes industry fixed effects identifies the effect of $MHHID$ on pay from variation over time in both pay and $MHHID$. A first concern is that the omitted variable that drives both $MHHID$ and pay evolved in endogenous ways over time. But that explanation is ruled out by the inclusion of time fixed effects, explained above. We discuss further endogeneity concerns below.

We are interested specifically in testing whether the ratio β/α from the theory is increasing in $MHHID$. To compute α and β we need to differentiate the expression 3 with respect to π_j^o and π_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 β/α with respect to the c.d.f. of $MHHID$ to be able to test Proposition 1:

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

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 $F(MHHID) = 0.5$.

In agreement with the literature (Albuquerque, 2009; Frydman and Saks, 2010; Custódio et al., 2013), all regressions are clustered at the firm level.

B Panel Regression Results

Table 4 presents the main results. We start with a benchmark result. Column (1) presents a regression corresponding to Equation (22) of executive pay on the explanatory variables performance of own and rival firm, and those variables interacted with market concentration (HHI). It most closely corresponds to the regressions in Aggarwal and Samwick (1999a) and do not include a common ownership measure. (Given our vastly differing sample (they: 1992-1993, we: 1993-2014), the use of 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.) The highly significant and positive coefficient (0.137) 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). HHI itself has no significant correlation with executive pay. The positive coefficient on *Rival* [firms' performance] indicates a lack of relative performance evaluation (RPE) in industries at the very bottom of the HHI distribution. The highly significant $Rival * HHI$ coefficient indicates that contracts come closer to the RPE prediction when an industry's HHI rank is higher or increases.

These result 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 can therefore be expected once $MHHID$ and its interactions with performance are introduced. That is indeed what we find.

Column (2) shows that the comparative statics of pay-performance sensitivity and pay-for-rival-performance sensitivity with respect to HHI are no longer present in the data. Instead, the formerly insignificant HHI coefficient turns highly significantly positive, indicating that executives in more concentrated industries take home higher salaries. The pay-performance and pay-for-rival-performance sensitivities themselves remain stable. However, those 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.

Column (3) includes standard controls. The pay-for-rival-performance sensitivity becomes statistically indistinguishable from zero, but the main result that relative performance evaluation decreases with common ownership is unaffected. The result that unconditional executive pay increases retains a positive point estimate but loses statistical significance.

Columns (4) and (5) reveal why this is the case: common ownership increases unconditional CEO pay, but not the unconditional pay for non-CEO top managers. But for both CEOs and non-CEO executives, the use of relative performance evaluation decreases with common ownership. The formal compensation ratio tests 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. Of course, the drop in significance is not surprising given that only about a sixth of the sample consists of CEOs.

The above results used CRSP 4-digit SIC codes as the industry definition. Previous research has shown great sensitivity of RPE tests (and many other corporate finance relationships) to industry definitions. We are therefore interested in examining how the correlations between common ownership and pay structure depends 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 comparison. Column (2) refines the definition of the rival group as the size tertile within the 4-digit SIC code, inspired by Albuquerque (2009) and as discussed above. The only significant difference of interest is that the $MHHID$ coefficient becomes highly significant, indicating that the average executive takes home 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.

These results also alleviate a further concern. One might reasonably hypothesize that there is greater measurement error with respect to a correct industry classification 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 in firm size. Taken together, these considerations might lead to a worry about a bias in the $MHHID$ by an imperfect size control. (A concern about the pay-for-(rival-)performance coefficients could be constructed similarly, although it would require additional levels of joint correlations.) Given that the results become stronger, not weaker, when tests are explicitly run within size groups, that concern is greatly attenuated.

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-firm performance 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.

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 goes in the opposite direction as size-splits and uses coarser definitions 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. 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 the results as more consistent with the interpretation that coarser industry definitions are less precise, rather than they improve accuracy by avoiding misclassifications.

C Robustness to the Measures of Pay and Common Ownership

Table 5 varied industry classifications. We next vary the measure of pay used as the outcome variable. "Flow" take home salary ($tdc1$ in Execucomp) for most executives is only a part of their total compensation. Stock and option grants are another, often very large, component. If there was a systematic correlation between the fraction of pay given as salary versus stock and options and the interaction between $MHHID$ and pay-for-(rival-)performance, the previous results might be biased, perhaps to an extent of giving qualitatively wrong information. While we have no particular reason in mind why that would be the case, it is clearly important whether this consideration has a major impact on our results.

To that end, in Appendix Table I, we use the Edmans et al. (2012) various measures of *wealth-*

performance sensitivity as the dependent variable, and examine how it depends 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. Because it is not clear how to reasonably construct a wealth-rival-performance measure (given the unobservability of executives entire portfolios), we cannot test whether the sensitivity of executive wealth to rival firms' performance also moves in the expected direction. We leave such an attempt to future research.

So far we have shown robustness of the main results to alternative industry definitions, and to alternative measures of pay. 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 sight, 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 $MHHID$. If a firm raised 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 inspect in how far our main results depend on this measure of common ownership in this dimension. To that end, in Appendix Table II 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.[12] 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)),

[12]We are grateful to Daniel Ferreira for suggesting that measure.

which the existing literature has shown to be most conductive 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. 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 ignores market shares altogether. In contrast, under the hypothesis that the standard model is right, and all our results are driven by the endogenous nature of market shares, the test should produce pure noise.

The coefficients in Appendix Table II indicate that the potential endogeneity of market shares is not the main driver of the results. All coefficients of interest retain their direction, albeit some drop a level of significance. The compensation ratio test is significant at least at 3 percent levels. These results are inconsistent with the notion that the way in which market shares are endogenous entirely drive the results, and that a market-share free measure of common ownership would lead to opposite conclusions.

D Remaining Concerns

A first worry we entertained is that sorting of executives with particular characteristics could be driving and thus invalidate the results. For example, less aggressive CEOs might sort into firms that are more held by index funds and that (for an unexplained reason) also happen to offer "flatter" compensation packages. We think this story is potentially realistic. The conclusions are however 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 shareholders in whose interest it is to change anything about it. Given this is indeed part of the story 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 mechanics 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. For one, it is not clear why the mechanical relationship should be stronger in industries and at times with greater common ownership. Much more importantly, however, the whole point of relative performance evaluation is that such mechanical effects should get differenced out by the optimal contract. The point of the paper is that shareholders have reduced incentives to do such differencing in industries with more common ownership.

A relevant remaining concern is, however, 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.

V 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. Specifically, the correlations could be driven by omitted variable or reverse causality concerns. This section uses a subset of the variation in ownership, namely that stemming from a mutual funds 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 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. Given that outflows as a reaction to the scandal don't give an immediate reason for passive funds to buy precisely that stock, it is likely that other active funds bought the stocks the affected fund families sold to meet their withdrawals. They may or may not have been large holders of other funds in the industry already. As a result, it is unclear ex ante whether the shock increased or decreased common ownership. But clearly, the shock led to changes in ownership networks.

Kisin (2011) first showed 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. 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 is correct, and if there is empirical support for the 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.

Formally, the instrument is the fraction of "scandal common ownership" by total common ownership for each industry, as of September 2003. 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. The instrument is the ratio of scandalous common ownership over all common ownership at the time of the scandal, September 2003,

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

In addition to instrumenting for $MHHID$, we also instrument for its interactions with own performance and rival performance, by multiplying the ratio with own and rival profits. 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 pay on the fitted values from the first-stage regression, for the same years as for the first stage.

The identifying assumption is that the Scandal *Ratio* 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 Scandal *Ratio*s were planning to set flatter pay schedules.

We can think of a violation of that assumption. For example, the (active and therefore less diversified) "scandalous" funds could – against their economic interest – have successfully advocated flatter pay structures to their portfolio firms, whereas the impact of such interventions was only felt with several years of a delay when the ownership structure had changed. We find such a scenario less likely than the scenario that all shareholders act in their economic interest, including the simple idea that diversified "passive" investors may not advocate for steeper pay packages that hurt their economic interests. In general, violations of the identification assumption are not unthinkable, but appear to us to be less plausible than the more straightforward explanation that economic agents act in accordance with their economic incentives.

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 Scandal *Ratio* and MHHID. Owing to the different industry definitions, the ratio takes the opposite sign in column (1) than in column (4), but is likewise highly significant. The *Ratio* interaction with profits and rival profits is likewise highly significant. More importantly, the F-statistic in all specifications is higher than 20 in all specifications.

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 and 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 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 relative performance evaluation.

VI 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 find that managers receive less pay for own-firm performance and more for rivals' performance when the firm's shareholders own large stakes in said rivals.

We thus illustrated the power of relaxing an important assumption present in most models in corporate finance: that product markets are perfectly competitive. (The assumption that shareholders are diversified is more common throughout financial economics.) The traditional models dismiss the importance of insights from industrial organization for finance perhaps for a combination of historical reasons and convenience: the assumption that markets are perfectly competitive affords that even when shareholders are diversified, perhaps to heterogeneous extents, and thus have anti-competitive economic interests to various extents, we can nevertheless safely assume that firms maximize their own profits (as opposed to an objective function that also takes other firms' profits into account, perhaps determined by a complicated voting procedure or other mechanisms). After all, competitive strategy is trivial when firms are price takers; there is simply nothing to strategize or disagree about. This insight is known as the Fisher Separation Theorem (FST); see Fisher (1930); DeAngelo (1981); Milne (1981) for discussions. Because the FST implies differences in shareholder preferences are inconsequential, thinking about how they can be resolved is unnecessary. The FST thus dramatically simplifies thinking about corporate financial decision making. Perhaps because of the perceived attractiveness of such simplifications, the assumption of perfect competition – which is necessary for the FST to hold – has been ubiquitous in the corporate finance literature ever since.[13]

The theoretical and empirical results in this paper show, however, that assuming that the FST holds (by assuming away a combination of diversification and market power) can lead to

[13] There is a literature in corporate finance that focuses on interactions between imperfect competition and financial strategy, and another literature on imperfect competition and optimal contracts. However, those literatures tend to assume implicitly that shareholders do not diversify across competitors.

qualitatively opposing interpretations of empirical facts and of its economic drivers. We find that the debate regarding which assumptions are appropriate for the literature going forward is an important one to have. 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. Under the FST, questions such as how shareholder disagreements are resolved, and how these disagreements affect the objective function and behavior of the firm, are moot. However, these questions become relevant when researchers recognize the possibility that markets can be less than perfectly competitive and that shareholders can be diversified across natural competitors at the same time.

A more pragmatic conclusion of our paper is that we answered a specific research question at the intersection of finance and industrial organization. The open question was which mechanism can induce the anti-competitive 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' anti-competitive interests. We also provided new anecdotal evidence on engagement meetings, voting patterns, and coordination of corporate governance activities among large previously-perceived-to-be-passive shareholders, and thus suggest how shareholder preferences enter compensation contracts.

However, we have no hard evidence that allows for a quantitative evaluation of how the contracts whose outcomes we measure are brought about. Perhaps our study will inspire a quantitative investigation of these practices. Finding direct evidence for the channels 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 being presented with such an opportunity, we leave this and related questions for future research.

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Figures

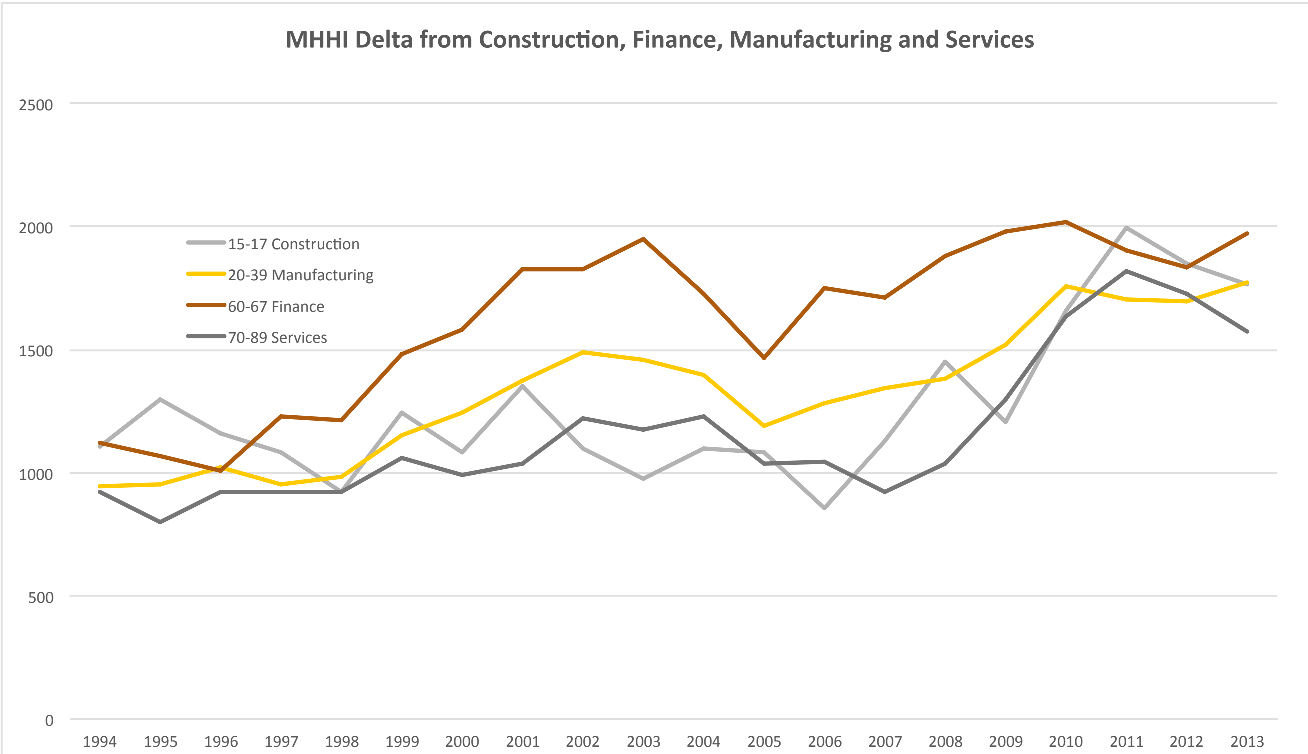

Figure I. Common Ownership Concentration (MHHID) in Various Sectors Over Time.
This figure plots the ownership concentration as measured by $MHHID$ averaged across four-digit SIC code industries for various sectors (construction, manufacturing, finance, and services) for the years 1994 to 2013.

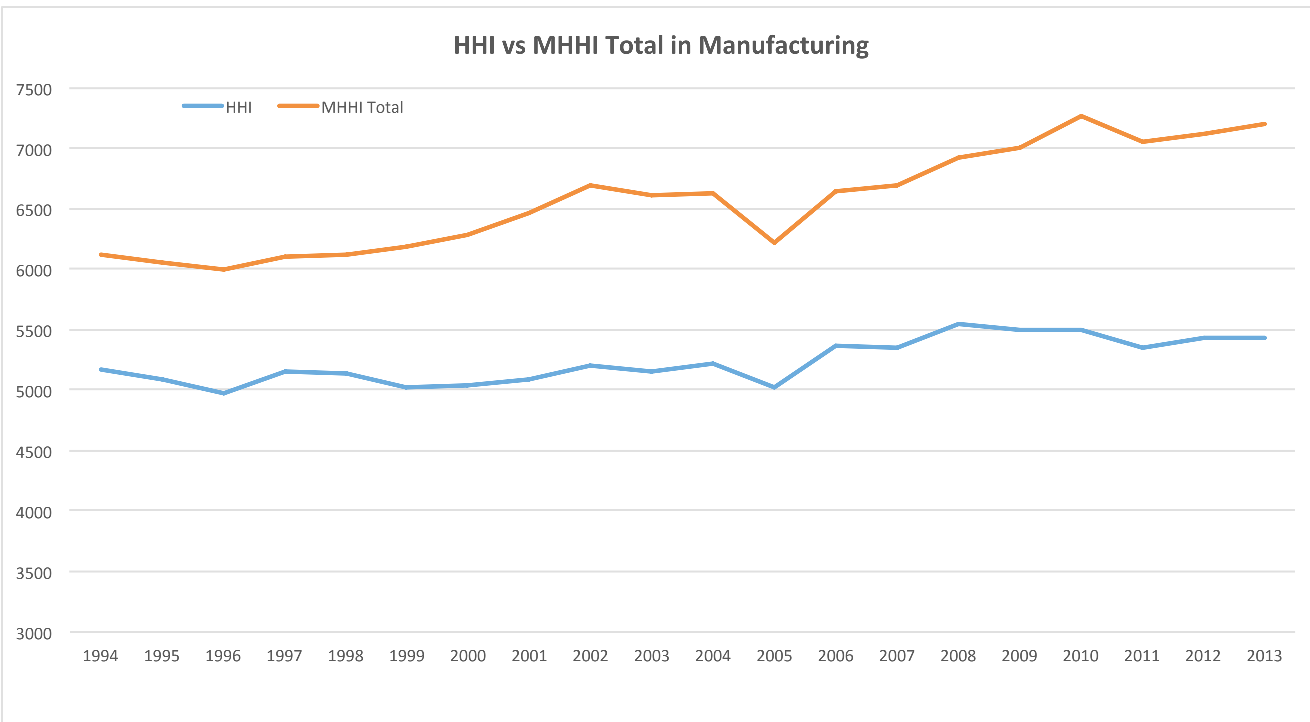

Figure II. Four-digit SIC HHI versus MHHI over time in Manufacturing.
This figure plots the product market and ownership concentration in manufacturing industries as measured by HHI and $MHHID$ averaged across four-digit SIC code industries in manufacturing for the years 1994 to 2013.

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 (36). 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 (38): 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 (38): 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-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.

Dep. Variables	(1) MHHID	(2) Own*MHHID	(3) Rival*MHHID	(4) MHHID	(5) Own*MHHID	(6) Rival*MHHID
Ratio	-0.0618***	15.56	-10.17	0.237***	-26.98*	0.366
	(-8.263)	(1.131)	(-0.790)	(21.20)	(-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 * Ratio	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 * Ratio	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 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 (38). 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

Appendix A: Related Literature

The existing literature has recognized links between (i) imperfect competition and (ii) optimal incentive contracts as well as between (iii) common ownership and (i) imperfect competition. This paper closes the triangle between all three concepts (i)-(iii) by establishing a link between (iii) common ownership and (ii) optimal incentive contracts.

The most closely related paper is Aggarwal and Samwick (1999a) (henceforth AS), who examine theoretically and empirically how the (optimal) use of RPE is related to product market competition, as measured by the HHI index of market concentration. By contrast, we are interested in how RPE relates to common ownership concentration in the industry (measured by O'Brien and Salop (2000)'s *MHHI delta* (MHHID), whereas total market concentration is $MHHI = HHI + MHHID$), holding fixed the traditional HHI measure of concentration.

The key differences from AS are as follows. First, theoretically, AS show that the relation between HHI and RPE depends on whether firms compete à la Bertrand or Cournot.[14] By contrast, we show that the effect of common ownership on the use of RPE is unambiguously negative. Second, we offer an even more extensive empirical treatment. We start with baseline specifications that are similar to AS's, except for the additional measure of concentration employed. Specifically, AS are interested in the coefficients of $HHI \times \pi_i$ and $HHI \times \pi_j$ (where π_i is the firm's performance andπ_j is the rivals' performance) and we are primarily interested in the coefficients of $MHHID \times \pi_i$ and $MHHID \times \pi_j$. An important difference is that in addition to exploiting variation across industries in HHI and $MHHID$, we can also identify the effect from time-series changes in those measures in a given industry. Moreover, we are able to identify the effect of common ownership concentration on RPE with plausibly exogenous variation in ownership resulting from from a

[14]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 (2007) while Cunat and Guadalupe (2005, 2009) provide empirical evidence.

trading scandal in 2003 affecting some mutual funds more than others, as exploited previously by Anton and Polk (2014).[15]

The theoretical idea that shareholder diversification leads to managerial incentive problems to which contracts need to be adapted has been around at least since Arrow (1962).[16] Gordon (1990) is the first to study (linear) RPE contracts under common ownership.[17] In Gordon's model, common ownership is modeled by exogenous positive effort spillovers on other firms in the industry. We model increases in common ownership explicitly. Similarly, his model does not feature any product market interactions. Our model makes these interactions explicit, and in particular separately investigates the Cournot and Bertrand case.[18]

Our paper also contributes to the large empirical and theoretical literature that examines the lack as well as the causes for the limited empirical support for RPE.[19] Broadly speaking, two classes of explanations exist for this lack of empirical support: "measurement" and "economics."

The "measurement" class of papers refines measures of pay and redefines the market definition (or, more precisely, the industry classification). Jayaraman et al. (2015) find more support for RPE after such modifications. We show that the "common ownership" effect is comparatively robust: it is present both when SIC or Hoberg-Phillips industry classifications are used to define competitors (Hoberg and Phillips, 2010, 2016).[20]

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[15] A more detailed description of the scandal is given by Zitzewitz (2006) and Zitzewitz (2009). Kisin (2011) uses the same shock for different purposes.

[16] "[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"

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

[18] Other papers that study the interplay of financial contracts and product market competition include Brander and Lewis (1986), Maksimovic (1988), Bolton and Scharfstein (1990), Scharfstein (1990), Chevalier (1995a,b), Phillips (1995), and Kovenock and Phillips (1997).

[19] 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), Bebchuk and Fried (2003), and Frydman and Jenter (2010). 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).

[20] Relatedly, De Angelis and Grinstein (2014) find that the use of relative performance provisions in compensation contracts is limited to select industries. Albuquerque (2009) argues that when peers are composed of similar

The "economics" class of responses proposes economic explanations for the absence or reduced importance of RPE. These explanations 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), aggregate shocks (Himmelberg and Hubbard, 2000), the absence of an appropriate comparison group (Albuquerque, 2014), outside opportunities (Oyer, 2004), and "keeping up with the Joneses" preferences (DeMarzo and Kaniel, 2016).[21] Given that the explanation we emphasize operates through aligning the objective function of the firm with shareholders' economic incentives, our paper is more closely related to the "economics" than to the "measurement" class of explanations for the difficulty of finding RPE in the data.

The present paper also relates to a literature and a continuing public debate on the causes of the increase in CEO pay over the past decades that is not entirely explained by observable changes (Bebchuk and Grinstein, 2005; Gabaix and Landier, 2008). In particular, we show that the rise of common ownership can explain part of the unexplained increase in top executive pay, both theoretically and empirically.

Our paper is further related to a recent stream of 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 anti-competitive shareholder incentives resulting from common ownership are translated into the anti-competitive behavior of firms. Our paper shows that managerial incentives are, at least to some extent, aligned with common shareholders' anti-competitive incentives. It also supports the view that anti-competitive effects caused by common ownership can obtain without "collusion," that is, without direct or indirect coordination between firms. This insight informs a vivid debate in the legal literature

industry-size firms, evidence is consistent with the use of RPE in CEO compensation.

[21] Among those, our theoretical analysis is closest in spirit to Aggarwal and Samwick (1999a) and DeMarzo and Kaniel (2016) who both study moral hazard models with linear RPE contracts. Whereas the former paper focuses on product market competition, the latter investigates the role of relative wealth concerns.

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).[22]

Finally, the summary statistics on common ownership concentration ($MHHID$), the main right-hand-side 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 ($MHHID$) across several industries and across time.

Appendix B: 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 who receives a linear compensation scheme given by

$$w_i = k_i + \alpha_i \pi_i + \beta_i \pi_j, \tag{26}$$

where the profits of firm i are given by

$$\pi_i = e_{1,i} + h e_{2,j} + \nu, \tag{27}$$

where ν is a common shock that is normally distributed with mean 0 and variance σ^2.

[22] 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 more generally (Appel et al., 2016). Schmalz (2015), Azar et al. (2015), and Schmalz (2016) go yet 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).

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, α_i, β_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 yield the optimal effort levels for both types of effort:

$$e_{1,i} = \alpha_i \quad \text{and} \quad e_{2,i} = h\beta_i. \tag{28}$$

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, the maximization problem of the majority owner of firm i becomes

$$\max_{\alpha_i, \beta_i} \quad x(\alpha_i + h\alpha_j - \frac{1}{2}\alpha_i^2 - \frac{1}{2}(h\beta_i)^2 - \frac{r}{2}(\alpha_i + \beta_i)^2\sigma^2) \tag{29}$$

$$+(1-x)(\alpha_j + h\alpha_i - \frac{1}{2}\alpha_j^2 - \frac{1}{2}(h\beta_j)^2 - \frac{r}{2}(\alpha_j + \beta_j)^2\sigma^2). \tag{30}$$

Thus, the first order conditions for α_i and β_i are given by

$$1 - \alpha_i - r\sigma^2(\alpha_i + \beta_i)^2 = 0x(-h^2\beta_i^2 - r\sigma^2(\alpha_i + \beta_i)^2) + xh^2 = 0. \tag{31}$$

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

$$\alpha^* = 1 - \frac{1}{x}\frac{h^2 r\sigma^2}{h^2 r\sigma^2 + h^2 + r\sigma^2}\beta^* = -1 + \frac{1}{x}\frac{h^2 r\sigma^2 + h^2}{h^2 r\sigma^2 + h^2 + r\sigma^2}. \tag{32}$$

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

Proposition 2. *The optimal incentive slope on own profits α^* is decreasing and the optimal incentive slope on rival profits β^* 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 α^* 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 ν in the firm's profits. The higher the impact on the other firm h, the degree of risk aversion r, and the variance σ^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

$$k^* = \frac{1}{2}(\alpha^*)^2 + \frac{1}{2}h^2(\beta^*)^2 + \frac{1}{2}r\sigma^2(\alpha^* + \beta^*)^2 - (\alpha^* + \beta*)(\alpha^* + h^2\beta^*). \tag{33}$$

Substituting the optimal values of α^* and β^* 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 β^* 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

$$w_i = k_i + \alpha_i \pi_i + \beta_i \pi_j, \tag{34}$$

where

$$\pi_i = (p_i - c)(B - dp_i + ep_j) + tm_i + \nu. \tag{35}$$

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

The agent has exponential utility and her certainty equivalent is

$$u_i = w_i - \frac{s}{2}m_i^2 - \frac{r}{2}(\alpha_i + \beta_i)^2\sigma^2, \tag{36}$$

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:

$$\begin{aligned}\max_{m_i,p_i} \quad & \alpha_i(p_i - c)(B - dp_i + ep_j + tm_i) + \beta_i(p_j - c)(A - dp_j + ep_i + tm_j) \\ & - \frac{s}{2}m_i^2 - \frac{r}{2}(\alpha_i + \beta_i)^2\sigma^2. \end{aligned} \tag{37}$$

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

$$m_i^* = \frac{t}{s}\alpha_i, \tag{38}$$

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

$$\begin{aligned}\max_{\alpha_i,\beta_i} \quad & x[(p_i - c)(B - dp_i + ep_j) + tm_i - \frac{s}{2}m_i^2 - \frac{r}{2}(\alpha_i + \beta_i)^2\sigma^2] \\ & +(1 - x)[(p_j - c)(B - dp_j + ep_i) + tm_j - \frac{s}{2}m_j^2 - \frac{r}{2}(\alpha_j + \beta_j)^2\sigma^2]. \end{aligned} \tag{39}$$

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 ν. That is, in the absence of strategic considerations, the optimal contract involves a large negative incentive slope β^*. 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 β^* increases because the owners induce a softening of competition through the incentive contracts. This change in β^* 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 ν. 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 which mirrors Proposition 3, 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.*

C Managerial Conflict of Interest

Our baseline model is similar to the setup in Fershtman and Judd (1987), Sklivas (1987), and Aggarwal and Samwick (1999a). It assumes that in the absence of explicit incentives in the form of α_i and β_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 α_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

$$U_i = P\pi_i + w_i = P\pi_i + k_i + \alpha_i\pi_i + \beta_i\pi_j. \tag{40}$$

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 C: Additional Empirical Results

Table A. I. Panel regressions with a market share-free measure of 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. (2012) 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. (2012).

	(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