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

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Abstract

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

Appendix A: Additional Theoretical Results

A Moral Hazard, Risk Aversion, and Multi-tasking

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

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

where the profits of firm i are given by

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

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

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

There are two owners, A and B. As before, we assume that they are symmetric such that A owns a share $x \geq 1/2$ of firm 1 and $1 - x$ of firm 2, and B owns $1 - x$ of firm 1 and x of firm 2. Each majority owner sets an incentive contract (k_i, 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 resulting from the agent i's wage bill given by equation (1) yield the optimal effort levels for both types of effort:

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

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

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

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

$$1 - \alpha_i - r\sigma^2(\alpha_i + \beta_i)^2 = 0 \tag{5}$$

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

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

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

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

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

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

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

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

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

where

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

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

The agent has exponential utility and her certainty equivalent is

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

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

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

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

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

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

which is unaffected by the price choice.

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

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

Generally solving the system of equations that results from the first order conditions of the two owners is not analytically feasible, even for the symmetric equilibrium. However, we can solve the system numerically to generate comparative statics. Consider first the following extreme case. When there is no product substitution $a = 0$ (hence $e = 0$), each firm is a separate monopolist. In the case of completely separate ownership ($x = 1$), the unique optimal contract is $\{\alpha^* = 1, \beta^* = -1\}$, which is an RPE contract that completely filters out the common shock 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 holds for all of our numerical simulations if product substitutability and risk aversion are sufficiently large.

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

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

C Managerial Conflict of Interest

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

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

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

Appendix B: Additional Empirical Results

Appendix Tables

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

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

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

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

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

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

PANEL B

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

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