Compensation Disclosures and Strategic Commitment: Evidence from Revenue-Based Pay

Internet Appendix

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IA1. Model of strategic delegation

Fershtman and Judd (1987) present a stylized model of strategic delegation in a world where: contracts are common knowledge; marginal costs are constant; and demand is linear. I relax these requirements, and show that in a rational expectations Cournot game, a firm will increase its use of revenue-based pay if rivals' beliefs about the agent's incentives become more responsive to changes in the agent's actual incentives. In what follows, I rely on the following three assumptions:

1. Profits are strictly decreasing in rival-firm production: $\frac{\partial \pi_i(q_i,q_j)}{\partial q_j} < 0$,
2. Quantity choices are strategic substitutes: $\frac{\partial q_j(\hat{q}_i)}{\partial \hat{q}_i} < 0$,
3. Own-firm production increases in the weight on revenue:[1] $\frac{\partial q_i}{\partial \lambda} > 0$,

where π_i is firm i's profit function, q_i is firm i's production quantity, q_j is the representative rival's production quantity, $\hat{q}_i$ is the representative rival's conjecture about q_i, and λ is the relative weight on revenue in manager i's objective function. For ease of analysis, I consider only one direction of the strategic interaction: the effect of q_i on q_j. This simplifying assumption does not qualitatively affect any of the conclusions below.

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[1] It can be shown that this is equivalent to assuming that marginal costs are strictly positive.

I begin my analysis by defining firm i's profits as a function of the contract, λ:

$$\Pi_i(\lambda) \equiv \pi_i\bigg(q_i(\lambda), q_j\big(\hat{q}_i(\hat{\lambda}(\lambda))\big)\bigg). \tag{IA1}$$

While the above equation may appear somewhat impenetrable, it merely states that firm i's profits are a function of q_i and q_j, and that q_j is, in turn, a function of the representative rival's conjecture about q_i (i.e., $\hat{q}_i$). Moreover, this conjecture is a function of the representative rival's beliefs about λ (i.e., $\hat{\lambda}$), where $\hat{\lambda}(\lambda)$ reflects the causal effect of λ on the rival's beliefs about λ. ($\hat{\lambda}$ may or may not be responsive to actual changes in λ.) The slope of $\hat{\lambda}(\lambda)$, $\frac{\partial \hat{\lambda}}{\partial \lambda}$, can be thought of as the sensitivity of the representative rival's beliefs about λ to changes in λ.

In what follows, I examine the effect of $\frac{\partial \hat{\lambda}}{\partial \lambda}$ on the nature of the optimal contract (i.e., the λ that maximizes firm i's profits). My analysis centers on understanding the marginal effect of λ on firm i's profits, which can be expressed as the total derivative:

$$\frac{d\Pi_i(\lambda)}{d\lambda} = \underbrace{\frac{\partial \pi_i}{\partial q_i} \cdot \frac{\partial q_i}{\partial \lambda}}_{\text{direct effect}} + \underbrace{\frac{\partial \pi_i}{\partial q_j} \cdot \frac{\partial q_j}{\partial \hat{q}_i} \cdot \frac{\partial \hat{q}_i}{\partial \hat{\lambda}} \cdot \frac{\partial \hat{\lambda}}{\partial \lambda}}_{\text{indirect effect}}. \tag{IA2}$$

As can be seen from eq. (IA2), λ affects profits through two channels: a direct effect, whereby λ affects profits through its impact on own-firm production, q_i; and an indirect effect, whereby λ affects profits through its impact on rival-firm production, q_j.

Below, I examine the effect of $\frac{\partial \hat{\lambda}}{\partial \lambda}$ on this total derivative by considering three cases: (1) contracts are private information, such that $\frac{\partial \hat{\lambda}}{\partial \lambda} = 0$; (2) contracts are public information, such that $\frac{\partial \hat{\lambda}}{\partial \lambda} = 1$ (á la Fershtman and Judd, 1987); and (3) contracts are imperfectly revealed, such that $\frac{\partial \hat{\lambda}}{\partial \lambda} \in [0, 1]$.

IA1.1. Private contracts

Suppose that contracts are private information. In this case, the representative rival's beliefs about λ will be entirely insensitive to actual changes in λ (i.e., $\frac{\partial\hat{\lambda}}{\partial\lambda} = 0$).[2] Substituting $\frac{\partial\hat{\lambda}}{\partial\lambda} = 0$ into eq. (IA2) shuts down the indirect channel, and simplifies the total derivative to:

$$\begin{aligned}\frac{d\Pi_i(\lambda)}{d\lambda} &= \frac{\partial\pi_i}{\partial q_i}\cdot\frac{\partial q_i}{\partial\lambda} + \frac{\partial\pi_i}{\partial q_j}\cdot\frac{\partial q_j}{\partial\hat{q}_i}\cdot\frac{\partial\hat{q}_i}{\partial\hat{\lambda}}\cdot 0 \\ &= \frac{\partial\pi_i}{\partial q_i}\cdot\frac{\partial q_i}{\partial\lambda}. \end{aligned} \tag{IA3}$$

By assumption, $\frac{\partial q_i}{\partial\lambda} > 0$, thus the first order condition is only satisfied if $\frac{\partial\pi_i}{\partial q_i} = 0$. That is, when contracts are private information, the optimal contract, λ^*, is [unsurprisingly] that which induces the manager to choose the profit-maximizing quantity. Intuitively, when λ is private information, there is no value in setting it strategically as it will not affect the representative rival's quantity—it will only push the firm's own manager to destroy value through profit-reducing over-production. Note that this does not imply that the optimal λ is zero; it could be that a positive weight on revenue is required to induce the manager to make the profit maximizing production decision.[3]

IA1.2. Public contracts

Suppose instead that contracts are public information, perfectly observable by rivals. In this case, $\frac{\partial\hat{\lambda}}{\partial\lambda} = 1$. Substituting $\frac{\partial\hat{\lambda}}{\partial\lambda} = 1$ into eq. (IA2) yields the total derivative:

$$\begin{aligned}\frac{d\Pi_i(\lambda)}{d\lambda} &= \frac{\partial\pi_i}{\partial q_i}\cdot\frac{\partial q_i}{\partial\lambda} + \frac{\partial\pi_i}{\partial q_j}\cdot\frac{\partial q_j}{\partial\hat{q}_i}\cdot\frac{\partial\hat{q}_i}{\partial\hat{\lambda}}\cdot 1 \\ &= \frac{\partial\pi_i}{\partial q_i}\cdot\frac{\partial q_i}{\partial\lambda} + \frac{\partial\pi_i}{\partial q_j}\cdot\frac{\partial q_j}{\partial\hat{q}_i}\cdot\frac{\partial\hat{q}_i}{\partial\hat{\lambda}}. \end{aligned} \tag{IA4}$$

Note that this total derivative differs from that of the private contracts case (eq. (IA3)) by the extra term, corresponding to the indirect effect: $\frac{\partial\pi_i}{\partial q_j}\cdot\frac{\partial q_j}{\partial\hat{q}_i}\cdot\frac{\partial\hat{q}_i}{\partial\hat{\lambda}}$. Each component of this expression

[2] Note that this does not imply that the representative rival's beliefs will be incorrect in equilibrium—only that, if firm i were to choose an off equilibrium value for λ, the representative rival's beliefs about λ would not be affected. Thus the representative rival would be unaware of the true value of λ at the time of choosing a quantity, q_j.

[3] For example, if higher levels of production volume require greater levels of personally costly effort, revenue-based pay could be used to encourage the value-maximizing quantity choice.

can be signed, using assumptions 1 through 3:[4]

$$\underbrace{\underbrace{\frac{\partial \pi_i}{\partial q_j}}_{(-)} \cdot \underbrace{\frac{\partial q_j}{\partial \hat{q}_i}}_{(-)} \cdot \underbrace{\frac{\partial \hat{q}_i}{\partial \hat{\lambda}}}_{(+)}}_{(+)} . \tag{IA5}$$

Thus, in the case of publicly disclosed contracts (where $\frac{\partial \hat{\lambda}}{\partial \lambda} = 1$), the marginal effect of revenue-weight on profit is strictly higher than in the private contracts case (where $\frac{\partial \hat{\lambda}}{\partial \lambda} = 0$). In the context of a first order condition, this implies that the value of λ^* for which $\frac{d\Pi_i(\lambda)}{d\lambda} = 0$ shifts to the right (i.e., becomes larger). Therefore, a switch from private contracts to the public contracts will result in an increase in revenue-based pay. The extent of this increase is moderated by the magnitudes of $\frac{\partial q_j}{\partial \hat{q}_i}$ and $\frac{\partial \pi_i}{\partial q_j}$; the greater the magnitudes, the further λ^* shifts to the right. That is, the shift towards revenue-based pay is greatest among firms with significant influence who also face significant competition from rivals (e.g., oligopolistic firms).

IA1.3. Imperfectly revealed contracts

The preceding analysis considers a stark transition from a non-disclosure (or "cheap-talk") world to one of perfect disclosure (i.e., $\frac{\partial \hat{\lambda}}{\partial \lambda} \in \{0, 1\}$). However, one could imagine that $\frac{\partial \hat{\lambda}}{\partial \lambda}$ lies on the interior between 0 and 1—that is, rivals' beliefs about managerial incentives are somewhat, but not completely, responsive to actual changes in managerial incentives.

Consider two sensitivities, $\frac{\partial \hat{\lambda}}{\partial \lambda} = \underline{\sigma}$ and $\frac{\partial \hat{\lambda}}{\partial \lambda} = \overline{\sigma}$, where $0 \le \underline{\sigma} < \overline{\sigma} \le 1$. In what follows, I examine the effect of transitioning from a $\underline{\sigma}$-sensitivity world to a $\overline{\sigma}$-sensitivity world. By freely choosing σ's, this analysis allows for an arbitrary change in belief sensitivity, covering all cases including a transition from non-disclosure to perfect disclosure, as well as any marginal increase in sensitivity.

[4] Note that the third term is $\frac{\partial \hat{q}_i}{\partial \hat{\lambda}}$, and not $\frac{\partial q_i}{\partial \lambda}$. While assumption 3 is about $sgn(\frac{\partial q_i}{\partial \lambda})$, rational expectations implies that $sgn(\frac{\partial \hat{q}_i}{\partial \hat{\lambda}}) = sgn(\frac{\partial q_i}{\partial \lambda})$. That is, the representative rival understands how agent i responds to her incentives.

If sensitivity changes from $\underline{\sigma}$ to $\overline{\sigma}$, the change in the total derivative, $\frac{d\Pi_i(\lambda)}{d\lambda}$, would be:

$$\begin{aligned}
\frac{d\Pi_i(\lambda)^{\underline{\sigma}}}{d\lambda} - \frac{d\Pi_i(\lambda)^{\overline{\sigma}}}{d\lambda} &\equiv \frac{\partial \pi_i}{\partial q_i} \cdot \frac{\partial q_i}{\partial \lambda} + \frac{\partial \pi_i}{\partial q_j} \cdot \frac{\partial q_j}{\partial \hat{q}_i} \cdot \frac{\partial \hat{q}_i}{\partial \hat{\lambda}} \cdot \underline{\sigma} \\
&\quad - \left[\frac{\partial \pi_i}{\partial q_i} \cdot \frac{\partial q_i}{\partial \lambda} + \frac{\partial \pi_i}{\partial q_j} \cdot \frac{\partial q_j}{\partial \hat{q}_i} \cdot \frac{\partial \hat{q}_i}{\partial \hat{\lambda}} \cdot \overline{\sigma} \right] \\
&= \underbrace{\underbrace{[\overline{\sigma} - \underline{\sigma}]}_{(+)} \cdot \underbrace{\frac{\partial \pi_i}{\partial q_j}}_{(-)} \cdot \underbrace{\frac{\partial q_j}{\partial \hat{q}_i}}_{(-)} \cdot \underbrace{\frac{\partial \hat{q}_i}{\partial \hat{\lambda}}}_{(+)}}_{(+)} \qquad \text{(IA6)}
\end{aligned}$$

Thus, if rivals' belief sensitivity increases from $\underline{\sigma}$ to some $\overline{\sigma} > \underline{\sigma}$, the optimal weight on revenue, λ^*, will become unambiguously greater, with the extent of the increase being moderated by firm i's influence, $\frac{\partial q_j}{\partial \hat{q}_i}$, and how much firm i cares to curtail competition, $\frac{\partial \pi_i}{\partial q_j}$. However, the magnitude of the change will depend heavily on the difference between $\underline{\sigma}$ and $\overline{\sigma}$. The greater the difference, the more dramatic the increase in revenue-based pay will be. If $\underline{\sigma} \approx \overline{\sigma}$, there would only be a slight increase in the use revenue-based pay.

IA1.4. Discussion: application to the CD&A setting

The CD&A required public firms to provide more detailed (and credible) disclosures about their executive pay practices. However, as discussed in Section 3 of the manuscript, the introduction of the CD&A did not cause a stark transition from mandated non-disclosure to perfect disclosure. It would be better characterized more softly as increasing the credibility/observability of managerial incentives, on average. In the context of the model, the CD&A can be considered a positive shock to the responsiveness of $\hat{\lambda}$ to changes in λ (i.e., a positive shock to $\frac{\partial \hat{\lambda}}{\partial \lambda}$).

As shown in Section IA1.3, such a shock would induce influential Cournot firms to increase the weight on revenue. The magnitude of the shift will depend on how much the CD&A affected $\frac{\partial \hat{\lambda}}{\partial \lambda}$. If the CD&A hardly affected $\frac{\partial \hat{\lambda}}{\partial \lambda}$ at all, either because pre-CD&A responsiveness was already quite high (e.g., due to 162(m)), or because post-CD&A responsiveness remained quite low (e.g., due to the backwards-looking nature of most CD&A disclosures), then the increase in revenue-based pay might be quite modest. Ultimately, it is an empirical question whether the CD&A setting constituted enough of a shock to $\frac{\partial \hat{\lambda}}{\partial \lambda}$ to produce any observable effects.

IA2. Additional empirical results

In the remainder of this Internet Appendix, I provide tabulated results from sensitivity tests. Table IA1 presents a replication of the main analysis using alternative measures of product market influence; Table IA2 presents a replication of the main analysis on a balanced panel of firms; Table IA3 presents a replication of the main analysis using logit specifications instead of linear probability models; and Table IA4 presents a replication of the main analysis using alternative fiscal year-end sample restrictions.

Table IA1: Alternative Measures of Product Market Influence

This table provides a replication of the analysis in Table 3 using six alternative measures of product market influence. Specifications (1) and (2) use $Share^{\gamma}$; Specifications (3) and (4) use $sqrt(Share)$; Specifications (5) and (6) use raw $Share$; Specifications (7) and (8) use $Leader$; Specifications (9) and (10) use $Top2$; Specifications (11) and (12) use $Top3$. Odd-numbered specification presents results for Cournot industries; Even-numbered presents results for Bertrand industries. Beneath each pair of specifications, I note the difference between coefficients and associated t-statistic.

	Outcome = Revenue-Based Pay											
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Share^{\gamma}$ x PostCD&A	0.359***	−0.138										
	(2.833)	(−0.959)										
	Dif=0.497***, t=2.598											
Sqrt(Share) x PostCD&A			0.219***	−0.035								
			(2.624)	(−0.328)								
			Dif=0.254*, t=1.873									
Share x PostCD&A					0.156*	0.020						
					(1.816)	(0.174)						
					Dif=0.135, t=0.930							
Leader x PostCD&A							0.114*	−0.023				
							(1.939)	(−0.370)				
							Dif=0.136, t=1.610					
Top2 x PostCD&A									0.155***	−0.042		
									(3.157)	(−0.764)		
									Dif=0.197***, t=2.682			
Top3 x PostCD&A											0.125***	−0.047
											(2.819)	(−0.888)
											Dif=0.172**, t=2.492	
Competition Type	Cournot	Bertrand	Cournot	Bertrand	Cournot	Bertrand	Cournot	Bertrand	Cournot	Bertrand	Cournot	Bertrand
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,728	1,389	1,728	1,389	1,728	1,389	1,728	1,389	1,728	1,389	1,728	1,389
R-squared	0.694	0.707	0.693	0.706	0.691	0.706	0.692	0.706	0.696	0.706	0.694	0.707

Table IA2: Balanced Panel

This table provides a replication of the analysis in Table 3 on a balanced panel of firms from the three year period surrounding CD&A adoption (2005 to 2007). Firms are included only if they are in the sample in all three years. The analysis is otherwise identical to that in Table 3. Specification (1) presents results for Cournot industries; Specification (2) presents results for Bertrand industries. The third column presents a test of the differences in coefficients across Specifications (1) and (2). Below each coefficient estimate, I report a t-statistic calculated using robust standard errors clustered by firm.

	Outcome = Revenue-Based Pay		
VARIABLES	(1)	(2)	(1) – (2)
ln(Share) x PostCD&A	0.040***	−0.007	0.047**
	(2.846)	(−0.511)	(2.385)
Competition Type	Cournot	Bertrand	
Firm Fixed Effects	Yes	Yes	
Year Fixed Effects	Yes	Yes	
Observations	420	352	
R-squared	0.821	0.859	

Table IA3: Logit Analysis

This table provides a replication of the analysis in Table 3 using a logistic regression instead of a linear probability model. The analysis is otherwise identical to that in Table 3. Specification (1) presents results for Cournot industries; Specification (2) presents results for Bertrand industries. The third column presents a test of the differences in coefficients across Specifications (1) and (2). Below each coefficient estimate, I report a t-statistic calculated using robust standard errors clustered by firm.

	Outcome = Revenue-Based Pay		
VARIABLES	(1)	(2)	(1) – (2)
ln(Share) x PostCD&A	0.624**	−0.256*	0.880***
	(2.058)	(−1.722)	(2.615)
Competition Type	Cournot	Bertrand	
Firm Fixed Effects	Yes	Yes	
Year Fixed Effects	Yes	Yes	
Observations	1,728	1,389	

Table IA4: Fiscal Year-End Sample Restrictions

This table provides a replication of the analysis in Table 3 using alternative criteria for inclusion in the sample. In Specifications (1) and (2), I include all firms regardless of fiscal year-end month. In Specifications (3) and (4), I include only firms with December year-ends. The analysis is otherwise identical to that in Table 3. Odd-numbered specifications presents results for Cournot industries; even-numbered specifications presents results for Bertrand industries. After each specification pair, I present a test of the differences in coefficients. Below each coefficient estimate, I report a t-statistic calculated using robust standard errors clustered by firm.

	Outcome = Revenue-Based Pay					
	Include all Firms			December Year-End Firms Only		
VARIABLES	(1)	(2)	(1) – (2)	(3)	(4)	(3) – (4)
ln(Share) x PostCD&A	0.034***	−0.011	0.045***	0.035***	−0.020	0.055***
	(2.803)	(−0.977)	(2.692)	(2.694)	(−1.567)	(3.019)
Competition Type	Cournot	Bertrand		Cournot	Bertrand	
Firm Fixed Effects	Yes	Yes		Yes	Yes	
Year-Month Fixed Effects	Yes	Yes		Yes	Yes	
Observations	2,064	1,728		1,576	1,193	
R-squared	0.679	0.718		0.677	0.707	