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Strategic Delegation Improves Cartel Stability

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Strategic Delegation Improves Cartel Stability*

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Abstract

Fershtman and Judd (1987) and Sklivas (1987) show that strategic delegation reduces firm profits in the one-shot Cournot game. Allowing for infinitely repeated interaction, strategic delegation can increase firm profits as it improves cartel stability.

Keywords: strategic delegation, collusion, cartel stability

JEL codes: D43, L13, L20, L41

1 Introduction

The strategic delegation literature shows how firms' profitability is *reduced* by delegating control to a manager being remunerated with a fraction of profit and sales (Fershtman and Judd, 1987; Sklivas, 1987—hereafter: FJS).[1] This paper extends FJS's seminal model to an infinitely repeated setting, thus allowing firm owners as well as managers to collude. Strategic delegation can then *increase* firms' profitability through improving cartel stability.[2]

Figure 1 illustrates this result graphically. Denoting π^* as the standard Cournot profit and π_d^* as the Cournot profit in the delegation equilibrium, Figure 1A depicts FJS's finding that delegation reduces profits in the one-shot Cournot game, independent of discount factor

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[1] This result holds for FJS's most elaborate case of Cournot competition.

[2] Relatedly, Lambertini and Trombetta (2002) extend Vickers' (1985) model—which can be rewritten in terms of FJS's model—and derive different results by implicitly assuming that firm owners do not react rationally on a managerial defection. Han (2011) comments on their analysis by considering rational players.

δ. However, allowing for infinitely repeated interaction, Figure 1B illustrates that delegation increases the set of discount factors for which firms can collude on the monopoly profit π^m from $[\delta^*, 1]$ to $[\delta^*_d, 1]$, thus increasing profits over the range $[\delta^*_d, \delta^*)$.

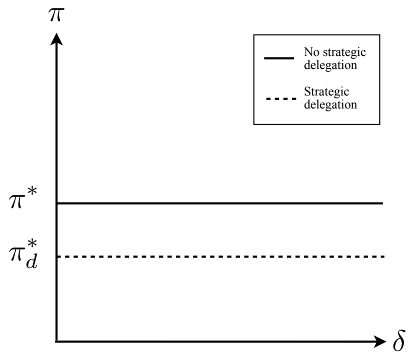

Figure 1A. Profits in the one-shot Cournot delegation game (FJS).

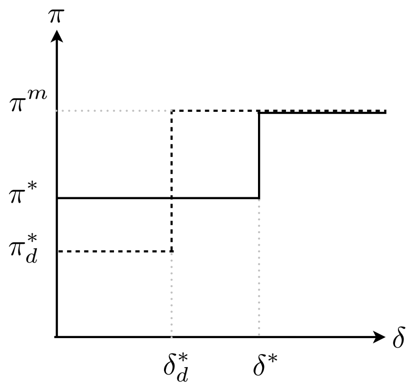

Figure 1B. Profits in the infinitely repeated Cournot delegation game.

The intuition is two-fold. First, a manager defecting from collusion can be fiercely punished by the owners as they can stop delegating control (and potentially fire the manager); this reduces the managers' incentive to defect. Second, the possibility of delegating control to managers allows collusion between owners on the product market to be supported by reverting to FJS's unprofitable delegation equilibrium; an owner defecting from collusion faces punishment profit $\pi^*_d < \pi^*$, which reduces the owners' incentive to defect.

The formal part of this paper is structured as follows. Section 2 presents the model and derives useful benchmarks. Section 3 characterizes the collusive delegation equilibrium (3.1), studies product market collusion by owners without delegation in equilibrium (3.2), and allows managers to be fired (3.3). Section 4 concludes.

2 The Infinitely Repeated Strategic Delegation Model

Consider FJS's delegation game as the stage game. Two homogenous firms $i \in \{1, 2\}$ produce at unit cost $c \geq 0$ and compete in quantities, facing linear demand

$$p = a - bQ, \qquad\qquad b > 0, a > c, \tag{1}$$

where p is market price, $Q = q_1 + q_2$ is total output, and q_i is output of firm i. Each firm i is owned by profit-maximizing owner i (female) who may delegate control to manager i (male) by remunerating him with a fraction α_i of profit π_i, plus a fraction $1-\alpha_i$ of sales S_i, that is,

$$M_i = \alpha_i \pi_i + (1-\alpha_i) S_i,$$

which can be rewritten as $M_i = (p - \alpha_i c) q_i$ by using (1). The managerial outside option is normalized to zero.[3] The timing of the stage game is:

1. Both owners simultaneously decide whether to delegate or to keep control.
2. If owner i delegates, she sets incentives α_i simultaneously with her rival.
3. The players in control of the firms simultaneously set quantities on the market.

Repeated Interaction. The stage game is played in each period $t \in \{1, ..., \infty\}$, allowing for collusion on three dimensions: the delegation decision, incentives α_i, and quantities q_i.

Owners and managers maximize their discounted stream of payoffs using discount factor δ_{own} and δ_{man}, respectively. To keep the analysis clean and to stay in line with the literature, collusion is on the monopoly quantity and punishment on the product market is characterized by reversion to the static Nash equilibrium forever. Everything is common knowledge and fully observable to all players. I focus on symmetric equilibria and denote i's rival by j.

Superscripts $\{*, m, D\}$ denote the Nash, collusive (monopoly), and deviating variables, respectively. Subscript d indicates that control of firm i is delegated to manager i. Collusion by player $x \in \{\text{owner } i, \text{manager } i\}$ is stable if and only if discount factor δ_x satisfies

$$\delta_x \geq \frac{[\text{defection payoff of player } x] - [\text{collusive payoff of player } x]}{[\text{defection payoff of player } x] - [\text{punishment payoff of player } x]}, \ \forall i \in \{1, 2\}. \tag{2}$$

Benchmarks. Consider the following benchmarks, which are formally derived in Appendix A. In FJS's one-shot Cournot delegation game, owners are captured in a prisoner's dilemma and cannot avoid delegation, resulting in equilibrium incentives, quantities, and payoffs

$$\alpha_{di}^* = \frac{6}{5} - \frac{a}{5c}, q_{di}^* = \frac{2(a-c)}{5b}, M_{di}^* = \frac{4(a-c)^2}{25b}, \pi_{di}^* = \frac{2(a-c)^2}{25b}, \tag{3}$$

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[3] In their original framework, FJS consider rewards $A_i + B_i M_i$. Since the managerial outside option is normalized to zero, owners optimally set $A_i = 0$ and B_i arbitrarily small, say $B_i = \epsilon_i > 0$. With delegation, owner i then earns $\pi_i - \epsilon_i M_i$ and manager i earns $\epsilon_i M_i$. In the limit when $\epsilon_i \downarrow 0$, (i) term $\epsilon_i M_i$ has an infinitesimally small impact on owner i's payoff and, therefore, she essentially behaves so as to maximize profit π_i, whereas (ii) manager i's payoff only consists of $\epsilon_i M_i$ and, therefore, she maximizes M_i.

which entails a lower profit than if owners would have been able to escape delegation and play the standard Cournot game,

$$q_i^* = \frac{a-c}{3b}, \pi_i^* = \frac{(a-c)^2}{9b}. \tag{4}$$

In the infinitely repeated standard Cournot game, collusion is stable if and only if

$$\delta_{own} \geq \frac{\pi_i^D - \pi_i^m}{\pi_i^D - \pi_i^*} = \frac{9}{17}, \text{ with}$$

$$q_i^m = \frac{a-c}{4b}, \pi_i^m = \frac{(a-c)^2}{8b}. \tag{5}$$

3 Delegation and Collusion

This section derives the collusive delegation equilibrium when managers cannot be fired (3.1), how the very *possibility* of delegation improves collusion on the product market between owners (3.2), and the collusive delegation equilibrium when managers can be fired (3.3).

3.1 The Collusive Delegation Equilibrium

The collusive delegation equilibrium yielding monopoly profits entails owners delegating control and colluding by giving *no* incentives for sales, thereby "selling the store" to managers who collude on the product market. Appendix B formally derives that

$$\alpha_{di}^m = 1, q_{di}^m = \frac{a-c}{4b}, M_{di}^m = \frac{(a-c)^2}{8b}, \pi_{di}^m = \frac{(a-c)^2}{8b}, \tag{6}$$

which is stable if and only if owners as well as managers have no incentive to defect.

Owner's defection. Owners can defect in two ways: they can (i) defect in stage 2 by setting incentives different from α_{di}^m, or (ii) defect in stage 1 by not delegating at all.

If owner i defects by setting different incentives, then managers optimally react with Nash competition in stage 3 so as to punish the deviant owner. Conditional on owner i defecting to incentives α_i, Nash quantities in stage 3 are $q_i(\alpha_i) = \frac{a+(1-2\alpha_i)c}{3}$ and $q_j(\alpha_i) = \frac{a+(\alpha_i-2)c}{3}$, yielding

$$\pi_i(\alpha_i) = \left(a - b\left(\frac{a+(1-2\alpha_i)c}{3} + \frac{a+(\alpha_i-2)c}{3}\right) - c\right)\frac{a+(1-2\alpha_i)c}{3},$$

which is maximized at $\alpha_i = \frac{5}{4} - \frac{a}{4c}$ with $\pi_i = \frac{(a-c)^2}{8b}$. As defection profit equals collusive profit, while triggering future punishment, owners would never make such a defection.

If instead owner i defects by not delegating at all, this triggers Nash competition with her rival's manager j in stage 3. Owner i and manager j respectively maximize $\pi_i(q_i, q_j) = (a - b(q_i + q_j) - c)\, q_i$ and $M_j(q_i, q_j) = (a - b(q_i + q_j) - c)\, q_j$, resulting in profit $\pi_i = \frac{(a-c)^2}{9b}$, which is lower than the collusive profit. Therefore, owners do not defect from the delegation decision. Lemma 1 summarizes.

Lemma 1 *Independent of the discount factor δ_{own}, owners do not defect from collusion.*

Managerial defection. If manager i defects from the collusive quantity $q_{di}^m = \frac{a-c}{4b}$, she does so by maximizing

$$M_i(q_i) = \left(a - b\left(q_i - \frac{a-c}{4b}\right) - c\right) q_i,$$

yielding deviant quantity $q_i = \frac{3(a-c)}{8b}$ with payoff $M_i = \frac{9(a-c)^2}{64b}$. To optimally prevent such a managerial defection, owners will want to avoid delegating control to managers in future periods, thereby fiercely punishing the manager with a zero payoff.[4] Using condition (2), i.e., $\delta_{man} \geq \left(\frac{9(a-c)^2}{64b} - \pi_{di}^m\right) / \left(\frac{9(a-c)^2}{64b} - 0\right)$, Lemma 2 states the resulting stability condition.

Lemma 2 *Managers do not defect from collusion if and only if $\delta_{man} \geq \frac{1}{9}$.*

Owner's commitment to avoid delegation. Whether owners are indeed able to punish managers by avoiding delegation depends on the owners' patience δ_{own}. Appendix D shows that the owners' commitment to *not* delegate suffers from FJS's prisoners dilemma when owners compete on quantities while keeping control, but it is no concern when owners collude on quantities while keeping control.

When owners punish a deviant manager by keeping control and colluding on quantities themselves, equilibrium profit during punishment is $\pi_i^m = \frac{(a-c)^2}{8b}$, while defection results in profit $\pi_i^D = \frac{9(a-c)^2}{64b}$, but triggers FJS's one-shot delegation equilibrium with profit $\pi_{di}^* = \frac{2(a-c)^2}{25b}$. Using condition (2), i.e., $\delta_{own} \geq \left(\pi_i^D - \pi_i^m\right) / \left(\pi_i^D - \pi_{di}^*\right)$, we arrive at Lemma 3.

Lemma 3 *After a manager defected, owners can commit to avoid delegation iff. $\delta_o \geq \frac{25}{97}$.*

As one can argue that discount factors are determined on financial markets, rational owners and managers with access to such markets can be assumed to be equally patient, i.e., $\delta_{own} = \delta_{man} = \delta$. Combining Lemmas 1, 2, and 3, gives the following proposition.

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[4] Appendix C checks that such punishment is indeed optimal, taking into account the owners' ability to commit to such punishment, and comparing the stability conditions with those in Lemmas 2 and 3.

Proposition 1 *Collusion is more stable in the infinitely repeated Cournot delegation model* $\left(\delta \geq \delta_d^* = \frac{25}{97}\right)$ *than in the infinitely repeated standard Cournot model* $\left(\delta \geq \delta^* = \frac{9}{17}\right)$.

Comparing profits in the infinitely repeated version of FJS's Cournot delegation model with those in the infinitely repeated standard Cournot model yields a lower equilibrium profit $\frac{2(a-c)^2}{25b} < \frac{(a-c)^2}{9b}$ for low discount factors $\delta < \frac{25}{97}$, but a higher equilibrium profit $\frac{(a-c)^2}{8b} > \frac{(a-c)^2}{9b}$ for intermediate discount factors $\frac{25}{97} \leq \delta < \frac{9}{17}$, and the same equilibrium profit $\frac{(a-c)^2}{8b}$ for high discount factors $\delta \geq \frac{9}{17}$. Figure 1B illustrates graphically and Proposition 2 summarizes.

Proposition 2 *In an infinitely repeated setting, FJS's static key result that delegation reduces firms' profitability does not hold for high discount factors, is reversed for intermediate discount factors, and survives for low discount factors.*

3.2 Product Market Collusion by Owners Without Delegation

Owners may choose not to delegate at all and collude on the product market themselves. As Lemma 3 indicates, owners can commit not to delegate and collude on quantities if and only if $\delta \geq \frac{25}{97}$. Hence, even without delegation in equilibrium, the very *possibility* of delegation improves the stability of collusion between owners.

3.3 Firing Managers

When managers can be fired, the collusive delegation equilibrium derived in (6) can be supported by firing the deviant manager, while hiring a new manager who continues to collude. Then, the owner's punishment strategy of no delegation becomes irrelevant and the only relevant constraint is that managers do not defect from collusion, i.e., $\delta_d^* \geq \frac{1}{9}$ by Lemma 2. Hence, firing managers makes the collusive delegation equilibrium even more stable.

4 Conclusion

Strategic delegation improves cartel stability. The intuition is that managers face a zero payoff after defection as owners will punish them by not delegating control anymore. Owners can commit to such punishment for a large set of discount factors, because an owner's defection from this punishment strategy results in FJS's unprofitable one-shot delegation equilibrium.

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Appendix

A Benchmarks

Outcome (4) is straightforwardly obtained as the static Nash equilibrium when both owners independently maximize $\pi_i = (p - c)\, q_i$, while outcome (5) is obtained when owners jointly maximize $\sum_{i=1}^{2} \pi_i$. When owner j produces $q_j^m = \frac{a-c}{4b}$, owner i's optimal defection quantity is $q_i^D = \arg\max_{q_i} \left\{ \left(a - b\left(q_i + q_j^m\right) - c\right) q_i \right\} = \frac{3(a-c)}{8b}$, leading to profit $\pi_i^D = \frac{9(a-c)^2}{64b}$. Thus, collusion is stable if and only if

$$\delta_o \geq \frac{\pi_i^D - \pi_i^m}{\pi_i^D - \pi_i^*} = \frac{9}{17}.$$

Consider FJS's one-shot Cournot delegation game. In stage 3, both managers independently maximize $M_i = (p - \alpha_i c)\, q_i$, leading to quantities as a function of incentives

$$q_i\left(\alpha_i, \alpha_j\right) = \frac{a - 2\alpha_i c + \alpha_j c}{3b}. \tag{7}$$

In stage 2, both owners substitute these into $\pi_i = \left(a - b\left(q_i + q_j\right) - c\right) q_i$ to independently maximize profit, yielding outcome (3), provided that both owners indeed delegate in stage 1.

If both owners keep control, they each earn the Cournot Nash profit $\pi_i^* = \frac{(a-c)^2}{9b}$. If owner i delegates, while owner j keeps control, then quantities as a function of incentives α_i become $q_i\left(\alpha_i, 1\right)$ and $q_j\left(1, \alpha_i\right)$ by (7). In stage 2, owner i then maximizes $\pi_i\left(\alpha_i\right) = \left(a - b\left(q_i\left(\alpha_i, 1\right) + q_j\left(1, \alpha_i\right)\right) - c\right) q_i\left(\alpha_i, 1\right)$, yielding $\alpha_i = \frac{5c-a}{4c}$ and

$$\pi_i = \frac{(a-c)^2}{8b}, \pi_j = \frac{(a-c)^2}{16b}. \tag{8}$$

Since owner i is better off by delegating if her rival keeps control, while owner j is worse off if she keeps control and her rival delegates compared to when both owners delegate, owners indeed delegate in stage 1.

B Equilibrium Incentives With Delegation

In stage 3, managers jointly maximize $\sum_{i=1}^{2} M_i$, yielding $q_1 + q_2 = \frac{a-\alpha_1 c}{2b} = \frac{a-\alpha_2 c}{2b}$. Focusing on symmetric equilibria, both managers set the same quantity as a function of incentives, $q_1 = q_2 = \frac{a-\alpha_1 c}{2b} = \frac{a-\alpha_2 c}{2b}$, which holds for symmetric incentives $\alpha_1 = \alpha_2 = \alpha$, resulting in $q_1 = q_2 = \frac{a-\alpha c}{2b}$. Substituting these in the owners' profit functions gives $\pi_i(\alpha) = \frac{[a-(2-\alpha)c](a-\alpha c)}{8b}$, which is maximized at $\alpha_1^m = \alpha_2^m = \alpha = 1$ in stage 2, resulting in outcome (6).

C Optimality of "Not Delegating Control" As the Punishment Strategy

This appendix shows that not delegating control is indeed the best strategy for owners to punish a deviant manager. First, suppose owners instead punish by reverting to "delegation and compete in setting incentives." We then get FJS's static delegation outcome (3) with managerial payoff $M_{di}^{*} = \frac{4(a-c)^2}{25b}$, which is actually higher than managerial payoff in the collusive delegation equilibrium $M_{di}^{m} = \frac{(a-c)^2}{8b}$, thereby making collusion fully unstable.

Second, suppose owners punish by reverting to "delegation and collude in setting incentives." In stage 3, managers set quantities as outlined in (7). In stage 2, owners substitute these into their joint profit function $\sum_{i=1}^{2} \pi_i$, which is maximized with symmetric incentives $\alpha_i = \frac{3}{4} + \frac{a}{4c}$, yielding $\pi_i = \frac{(a-c)^2}{8b}$ and $M_i = \frac{(a-c)^2}{18b}$. If owner i deviates by setting different incentives, straightforward algebra leads to the optimal deviating incentive being $\alpha_i = \frac{21}{16} - \frac{5a}{16c}$ with profit $\pi_i = \frac{25(a-c)^2}{128b}$. This triggers punishment by FJS's static Nash equilibrium with $\pi_{di}^{*} = \frac{2(a-c)^2}{25b}$. Thus, owners can commit to punishment iff. $\delta_{own} \geq \frac{\frac{25(a-c)^2}{128b} - \frac{(a-c)^2}{8b}}{\frac{25(a-c)^2}{128b} - \pi_i^{dN}} = \frac{25}{41}$, and managers do not defect in the first place iff. $\delta_{man} \geq \frac{\frac{9(a-c)^2}{64b} - \frac{(a-c)^2}{8b}}{\frac{9(a-c)^2}{64b} - \frac{(a-c)^2}{18b}} = \frac{9}{49}$. These stability conditions are more difficult to satisfy than $\delta_{own} \geq \frac{25}{97}, \delta_{man} \geq \frac{1}{9}$ from Lemmas 2 and 3.

D Owner's Commitment to Avoid Delegation

Suppose owners punish a deviant manager by keeping control, while *competing on the product market.* Owner i then earns $\pi_i^{*} = \frac{(a-c)^2}{9b}$. If she defects from the punishment scheme by delegating control, then in stage 3 manager i and owner j compete with respective payoffs $M_i(q_i, q_j) = (a - b(q_i + q_j) - \alpha_i c) q_i$ and $\pi_j(q_i, q_j) = (a - b(q_i + q_j) \; - c) q_j$, yielding quantities $q_i(\alpha_i) = \frac{a + (1-2\alpha_i)c}{3}$, $q_j(\alpha_i) = \frac{a + (\alpha_i - 2)c}{3}$ and profit

$$\pi_i(\alpha_i) = \left(a - b\left(\frac{a + (1-2\alpha_i)c}{3} + \frac{a + (\alpha_i - 2)c}{3}\right) - c\right)\frac{a + (1-2\alpha_i)c}{3},$$

which owner i maximizes at $\pi_i = \frac{(a-c)^2}{8b}$ with $\alpha_i = \frac{5}{4} - \frac{a}{4c}$. Since defection triggers punishment by FJS's one-shot delegation Nash equilibrium with profit $\pi_{di}^{*} = \frac{2(a-c)^2}{25b}$ (see equations (3)), owners can commit to punishment if and only if $\delta_{own} \geq \frac{\frac{(a-c)^2}{8} - \frac{(a-c)^2}{9}}{\frac{(a-c)^2}{8} - \frac{2(a-c)^2}{25}} = \frac{25}{81}$.

Now suppose owners punish a deviant manager by keeping control, while *colluding on the product market.* Owner i then earns $\pi_i^{m} = \frac{(a-c)^2}{8b}$, while defection from the punishment scheme by delegating control results in competition between manager i and owner j with defection profit $\pi_i = \frac{(a-c)^2}{8b}$ (see equations (8)). Since defection profit equals collusive profit, owners will not defect from punishment through delegation.

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