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Strategic Delegation Improves Cartel Stability*

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Abstract

Fershtman and Judd (1987) and Sklivas (1987) show how strategic delegation in the one-shot Cournot game reduces firm profits. However, with infinitely repeated interaction, strategic delegation allows for an improvement in cartel stability compared to the infinitely repeated standard Cournot game, thereby actually increasing profits.

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 – see Fershtman and Judd (1987) and Sklivas (1987) (hereafter: FJS). This contribution extends FJS’s seminal model to an infinitely repeated setting, thereby allowing firm owners as well as managers to collude. Strategic delegation then actually increases firms’ profitability through improving cartel stability compared to the non-delegation Cournot game.

*I thank Jeanine Miklos-Thal, Maarten Pieter Schinkel, Bert Schoonebeek, and Jeroen van de Ven for constructive comments. Opinions and errors are mine. This result holds for FJS’s most elaborate case of Cournot competition. Fershtman and Judd (1987) and Sklivas (1987) simultaneously published their results with identical models. Lambertini and Trombetta (2002) extend Vickers’ (1985) model – which can be rewritten in terms of FJS – and derive the opposite result by implicitly assuming that firm owners do not react rationally on a managerial defection. Han (2010a) comments on their analysis by considering rational owners.
The intuition is two-fold. First, a manager defecting from collusion can be fiercely punished by owners as they can stop delegating control. Second, this punishment strategy is more stable than collusion in the infinitely repeated standard Cournot game, because it is supported by the threat of reverting to FJS’s unprofitable one-shot delegation equilibrium. Hence, FJS’s key result of “unprofitable delegation” actually helps owners to credibly commit to a fierce punishment strategy, thereby increasing cartel stability and thus firm profits.

2 The repeated strategic delegation model

Consider FJS’s delegation game. Two homogenous firms \( i = 1, 2 \) produce at unit cost \( c \geq 0 \) and compete in quantities facing linear demand

\[
p = a - bQ, \quad b > 0, a > c,
\]

where \( p \) is market price, \( q_i \) is output of firm \( i \), and \( Q = q_1 + q_2 \) is total output. Each firm \( i \) is owned by profit-maximising owner \( i \) (female) who may delegate control to manager \( i \) (male) by remunerating him with a fraction \( \alpha_i \) of profit \( \pi_i \) plus a fraction \( 1 - \alpha_i \) of sales \( S_i,^4 \)

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

which can be rewritten as \( M_i = (p - \alpha_i c) q_i \). The manager earns nothing if the owner does not delegate control to him. 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 \( \alpha_i \) (possibly) simultaneously with her rival, and
3. the players in control of the firms simultaneously set quantities on the product market.

Extending FJS, this stage game is infinitely repeated in each period \( t = 1...\infty \), thereby allowing for collusion on three dimensions: the delegation decision, incentives, and quantities.

Owners and managers maximise their discounted stream of payoffs using discount factor \( \delta_o \) and \( \delta_m \), 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 characterised 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 \( j \).

\(^4\)More generally, FJS consider rewards \( A_i + B_i M_i \). The multiplication with \( B_i \) is irrelevant in a repeated framework as it cancels out in each period, while Han 2010b shows how a fixed payment \( A_i \) improves stability.
3 Delegation improves the stability of collusion

Owners’ and managers’ behavior, respectively, is labelled by $o, m \in \{N, C, D\}$, denoting Nash ($N$), collusion ($C$), and defection ($D$). I use those labels as superscripts for the decision and payoff variables. Collusion by owners and managers is stable if and only if

$$\delta_o \geq \frac{\pi_i^{D,m} - \pi_i^{C,m}}{\pi_i^{D,m} - \pi_i^{N,m}} \quad \text{and} \quad \delta_m \geq \frac{M_i^{o,D} - M_i^{o,C}}{M_i^{o,D} - M_i^{o,N}} \quad \text{for } i = 1, 2. \quad (1)$$

3.1 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

$$\alpha_{i}^{NN} = \frac{6}{5} - \frac{a}{5c}, q_{i}^{NN} = \frac{2(a - c)}{5b}, M_{i}^{NN} = \frac{4(a - c)^2}{25b}, \pi_{i}^{NN} = \frac{2(a - c)^2}{25b}, \quad (2)$$

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

$$q_{i}^{N} = \frac{a - c}{3b}, \pi_{i}^{N} = \frac{(a - c)^2}{9b}, \quad (3)$$

where superscript $m$ for managerial behavior is omitted as managers do not participate. In the infinitely repeated standard Cournot model, collusion is stable if and only if $\delta_o \geq \frac{9}{17}$ with

$$q_{i}^{C} = \frac{a - c}{4b}, \pi_{i}^{C} = \frac{(a - c)^2}{8b}. \quad (4)$$

3.2 Collusive equilibrium with delegation

In the infinitely repeated version of FJS’s delegation game, the collusive delegation equilibrium yielding full monopoly profits entails owners delegating control by giving no incentives for sales, thereby “selling the store” to managers whose objective then is to maximise profit. Appendix B formally derives that

$$\alpha_{i}^{CC} = 1, q_{i}^{CC} = \frac{a - c}{4b}, M_{i}^{CC} = \frac{(a - c)^2}{8b}, \pi_{i}^{CC} = \frac{(a - c)^2}{8b}, \quad (5)$$

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 $\alpha_i^{CC}$, 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 $\alpha_i^{DN}$, Nash quantities in stage 3 are $q_i = \frac{a + (1 - 2\alpha_i)c}{3}$ and $q_j = \frac{a + (\alpha_i - 2)c}{3}$, yielding

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

which is maximised at $\pi_i^{DN} = \frac{(a-c)^2}{8b}$ with $\alpha_i^{DN} = \frac{5}{4} - \frac{a}{4c}$. 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, this triggers Nash competition with her rival’s manager $j$ in stage 3. They respectively maximise $\pi_i = (a - b(q_i - q_j) - c) q_i$ and $M_j = B (a - b(q_i - q_j) - c) q_j$, leading to profit $\pi_i^{DN} = \frac{(a-c)^2}{9b}$, which is lower than the collusive profit. Therefore, owners do not defect from the delegation decision. Lemma 1 summarises.

**Lemma 1** Independent of the discount factor $\delta_o$, owners do not defect from collusion.

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

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

yielding deviant quantity $q_i^{CD} = \frac{3(A-c)}{8b}$ with payoff $M_i^{CD} = \frac{9(a-c)^2}{64b}$. To optimally prevent such a managerial defection, owners will try to commit to avoid delegating control in future periods, thereby fiercely punishing the manager with a zero payoff.\(^5\) Using constraint (1b), i.e. $\delta_m \geq \frac{M_i^{CD} - M_i^{CC}}{M_i^{CD} - 0}$, Lemma 2 states the resulting stability condition.

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

Owner’s commitment to avoid delegation. Whether owners are indeed able to punish managers by avoiding delegation depends on the owners’ patience $\delta_o$. Appendix C shows that the owners’ commitment to not delegate suffers from FJS’s prisoners dilemma when owners compete in quantities while keeping control, but it is no concern when owners collude on quantities while keeping control.\(^5\)

\(^5\)Appendix D checks that such punishment is indeed optimal taking into account the owners’ ability to commit to such punishment.
When owners punish a deviant manager by keeping control and colluding on quantities themselves, equilibrium profit during punishment is \( \pi_i^C = \frac{(a-c)^2}{8b} \), while defection results in profit \( \pi_i^D = \frac{9(a-c)^2}{64b} \), but triggers FJS’s one-shot delegation equilibrium with profit \( \pi_i^{NN} = \frac{2(a-c)^2}{25b} \). By constraint \( (1a) \), i.e. \( \delta_o \geq \frac{\pi_i^D - \pi_i^C}{\pi_i^{NN} - \pi_i^C} \), Lemma 3 states the resulting stability condition.

**Lemma 3** Owners can commit to avoid delegation after a managerial defection iff. \( \delta_o \geq \frac{25}{97} \).

Since 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. \( \delta_o = \delta_m = \delta \). Combining Lemmas 1, 2 and 3, we then arrive at the following Proposition on cartel stability.

**Proposition 1** Collusion is stable for a larger set of discount factors in the infinitely repeated Cournot delegation model \( (\delta \geq \frac{25}{97}) \) than in the infinitely repeated standard Cournot model \( (\delta \geq \frac{9}{17}) \).

The intuition is that managers face an extremely bad consequences from defection as owners will punish them by not delegating control in the future. Owners can commit to such punishment for a large set of discount factors, because an owner’s defection from this punishment results in FJS’s unprofitable one-shot delegation equilibrium.

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 \( \frac{2(a-c)^2}{25b} < \frac{(a-c)^2}{96} \) for low discount factors \( \delta < \frac{25}{97} \), but a higher equilibrium profit \( \frac{(a-c)^2}{8b} > \frac{(a-c)^2}{96} \) 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 \( \delta \geq \frac{9}{17} \). The following Proposition summarises.

**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.

### 4 Concluding Remark

Whether delegation improves cartel stability and increases profits in more general frameworks is an ongoing debate. Following pioneering work by Spagnolo (2000, 2005), more recent contributions by Aubert (2009) and Angelucci and Han (2010) model this question in a principal-agent framework, thereby studying issues related to information asymmetries.
Appendix A

Outcome (3) is straightforwardly obtained as the static Nash equilibrium when both owners independently maximise $\pi_i = (p - c) q_i$, while outcome (4) is obtained when owners jointly maximise $\sum_{i=1}^{2} \pi_i$. When owner $j$ produces $q_j^C = \frac{a-c}{4b}$, owner $i$’s optimal defection quantity is $q_i^D = \arg \max_{q_i} \{(a - b (q_i + q_j^C) - c) q_i\} = \frac{3(a-c)}{8b}$, leading to profit $\pi_i^D = \frac{9(a-c)^2}{64b}$. Collusion is thus stable if and only if $\delta_o \geq \frac{(\pi_i^D - \pi_i^C)}{(\pi_i^D - \pi_i^N)} = \frac{9}{17}$.

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

$$q_i(\alpha_i, \alpha_j) = \frac{a - 2\alpha_i c + \alpha_j c}{3b}. \quad (6)$$

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

If both owners keep control, they each earn the Cournot Nash profit $\pi_i^N = \frac{(a-c)^2}{9b}$. If owner $i$ delegates, while owner $j$ keeps control, then quantities as a function of incentives $\alpha_i$ become $q_i(\alpha_i, 1)$ and $q_j(1, \alpha_i)$ by (6). In stage 2, owner $i$ then maximises $\pi_i = (a - b (q_i(\alpha_i, 1) + q_j(1, \alpha_i)) - c) q_i(\alpha_i, 1)$, leading to $\alpha_i = \frac{5c-a}{4c}$ with profits

$$\pi_i = \frac{(a-c)^2}{8b}, \pi_j = \frac{(a-c)^2}{16b}. \quad (7)$$

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.

Appendix B

In stage 3, managers jointly maximise $\sum_{i=1}^{2} M_i$, 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, $q_1 = q_2 = \frac{a-\alpha c}{2b} = \frac{a-\alpha c}{2b}$, 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 $\pi_i = \frac{[a-(2-\alpha)c](a-\alpha c)}{8b}$, which is maximised at $\alpha_1^{CC} = \alpha_2^{CC} = \alpha = 1$ in stage 2, resulting in outcome (5).
Appendix C

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

$$\pi_{i}^{DN} = \left( a - b \left( \frac{a + (1 - 2\alpha_i) c}{3} + \frac{a + (\alpha_j - 2) c}{3} \right) - c \right) \frac{a + (1 - 2\alpha_i) c}{3},$$

which owner $i$ maximises at $\pi_{i}^{DN} = \frac{(a-c)^2}{8b}$ with $\alpha_{i}^{DN} = \frac{5}{4} - \frac{a}{4c}$. Since defection triggers punishment by FJS’s one-shot delegation Nash equilibrium with profit $\pi_{i}^{NN} = \frac{2(a-c)^2}{25b}$ (see equations (2)), owners can commit to punishment if and only if $\delta_o \geq \frac{(A-c)^2 - (A-c)^2}{(A-c)^2 - 2(a-c)^2} = \frac{25}{81}$.

Now suppose owners punish a deviant manager by keeping control, while colluding on the product market. Owner $i$ then earns $\pi_{i}^{C} = \frac{(a-c)^2}{8b}$, while defection from the punishment scheme by delegating control results in competition between manager $i$ and owner $j$ with defection profit $\pi_{i}^{D} = \frac{(a-c)^2}{8b}$ – see equation (7). Since defection profit equals collusive profit, owners will not defect from punishment through delegation.

Appendix D

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 outcome (2) with managerial payoff $M_{i}^{NN} = \frac{4(a-c)^2}{25b}$, which is actually higher than managerial payoff in the collusive equilibrium $M_{i}^{CC} = \frac{(a-c)^2}{8b}$, thereby making collusion fully unstable in the first place.

Second, suppose owners punish by reverting to ‘delegation and collude in setting incentives’. In stage 3, managers set quantities as outlined in (6). In stage 2, owners substitute these into their joint profit function $\sum_{i=1}^{2} \pi_i$, which is maximised with symmetric incentives $\alpha_{i}^{CN} = \frac{3}{4} + \frac{a}{4c}$, yielding $\pi_{i}^{CN} = \frac{(a-c)^2}{8b}$ 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 $\alpha_{i}^{DN} = \frac{21}{16} - \frac{5a}{16c}$ with profit $\pi_{i}^{DN} = \frac{25(a-c)^2}{128b}$. This triggers punishment by FJS’s static Nash equilibrium with $\pi_{i}^{NN} = \frac{2(a-c)^2}{25b}$. Thus, owners can commit to punishment iff. $\delta_o \geq \frac{\pi_{i}^{DN} - \pi_{i}^{D}}{\pi_{i}^{NN} - \pi_{i}^{D}} = \frac{25}{41}$, and managers do not defect in the first place iff. $\delta_{m} \geq \frac{1}{16} - \frac{5a}{16c} - \frac{9}{49} \frac{(a-c)^2}{25b}$. These stability conditions are more difficult to satisfy than $\delta_o \geq \frac{25}{97}$, $\delta_{m} \geq \frac{1}{5}$.
References


