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Abstract

We examine an effect of *strategic delegation* on the competition behavior of indebted firms and welfare in a Cournot duopoly with demand uncertainty. We establish that the owners of each firm delegate their tasks and decisions to a manager when the demand is *sufficiently large* but one firm chooses no delegation and the other chooses delegation when the demand is *small*. This result is consistent with the duopoly competition example between the Mitsui Gomei Kaisya and Suzuki & Co. from the late Meiji era to Taisho era in Japan.

Keywords: indebted firms, delegation, managerial incentives, and Cournot duopoly
JEL classification: G32, L13, L12

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1 Introduction

Separation of ownership and management allows firms to commit to behavior other than profit-maximization. Certain empirical evidence implies that they do not behave as profit-maximizers. For example, Amihud and Kamin (1979) supported Baumol (1958)'s hypothesis that revenue-maximizing behavior is more prevalent among oligopolistic, management-controlled firms. From a managerial-incentive perspective, Vickers (1985) and Fershtman and Judd (1987) theoretically justified this empirical evidence. Vickers (1985) established that firms may obtain higher profits by delegating to managers who do not behave as profit-maximizers. Fershtman and Judd (1987) examined the incentives that owners of competing firms in an oligopoly give managers as compensation, inducing the managers to maximize linear combinations of the objectives of profits and sales. They showed that owners of duopolistic firms always incentivize sales more as compared to profit. These works have motivated a large amount of research concerning *strategic delegation*[1].

Brander and Lewis (1986) theoretically considered the relationships between an oligopolistic product market and financial structure, and showed that limited liability may induce a leveraged firm to a more aggressive output stance[2]. As in the case of strategic delegation, there are also many works concerning financial structure[3].

An oligopolist is assumed to be a limited liability company in previous financial structure literature, and a profit-maximizer. The existing literature is also limited by focusing only on a symmetric equilibrium in that all firms in the oligopoly have a homogeneous

[1] See Sengul, Gimeno, and Dial (2012) for a recent survey of the works on strategic delegation in the economics and management literature.

[2] Etro (2010) characterized the optimal financial structure as a strategic device to optimize the value of a firm competing in a market for which entry is endogenous, and showed the general optimality of moderate debt financing under both quantity competition and price competition in an oligopoly with cost uncertainty.

[3] See Neff (2003) for related literature.

organizational structure.

In the real world, however multiple firms with heterogeneous organizational structures and strategies compete in a duopoly under risk. As a real example of oligopoly, we would mention the competition between the Mitsui Gomei Kaisya and Suzuki & Co. from the late Meiji era to Taisho era (1887–1911, 1912–1926)[4]. These two firms are the genesis of Japanese *sogoshosha* (general trading company) as *substantial unlimited partnership* firms[5]. The intense competition in the global trading business between Suzuki and Mitsui in the first half of the Taisho era is well-known[6]. Roberts (1973) mentions that Baron Mitsui Hachiroemon, the president of Mitsui Gomei Kaisya, had delegated daily managerial decision-making to his general staff (managers)[7]. According to Katsura (1975), Suzuki & Co. took exclusive charge of the over-all administration and investment decision-making of Suzuki's subsidiaries, and thus did not delegate decision-making at these subsidiaries to their managers[8].

In this paper, we therefore examine whether an owner delegates its tasks, decisions,

[4]We thank Daniel Spulber for suggesting that we should search and present *an original real example for our study* by introducing us to *his seminal book*, "*Famous Fables in Economics*" on an earlier version of this paper.

[5]Katsura (1975) mentions that in 1909, Mitsui established the Mitsui & Co. (Mitsui Gomei Kaisya), an unlimited partnership and holding company with the Mitsui Bussan as one of its subsidiaries. Suzuki was incorporated into an unlimited partnership, Suzuki & Co. (Gomei Suzuki). According to Roberts (1973, p. 172), "in 1909 (Baron Takashi) Masuda organized a holding company, called Mitsui Gomei Kaisya, to supplant the outdated partnership as supreme headquarters of the business empire. ... The initial capital of Gomei Kaisya was fifty million yen, all of it invested by the eleven Mitsui houses, whose heads remained its sole owners."

[6]Katsura (1975, p. 41) mentions, "In short period, Suzuki joined Mitsui Bussan as one of the only two Japanese trading companies that could trade on such a large scale that they were forced to rely not only upon the Specific Bank of Yokohama but also upon London merchant bankers in their foreign exchange dealings."

[7]Specifically, Roberts (1973, p. 172) states, "Baron Mitsui Hachiroemon Takamine was president of Gomei Kaisha but, as usual, business affairs were managed by general staff, among whom Masuda, Dan Takuma, and Ikeda Seihin another Harvard graduate were most powerful."

[8]See Katsura (1975, p. 43). Roberts (1973) also mentions, "Kaneko (who is an actual president of Suzuki & Co.) had secured a controlling interest in the Sixty-fifth Bank in Kobe ... Because of his mania for keeping absolute control of the company in the hands of the Suzuki family, he had resisted opening the concern's enterprises to public subscription, which would have invited invasion by zaibatsus."

and responsibility to a manager affects the equilibrium outcome and welfare in a Cournot duopoly with demand uncertainty. To derive a clear result and to ensure an asymmetric equilibrium, we modify the models of Fershtman and Judd (1987) and Brander and Lewis (1986) as follows. Fershtman and Judd (1987) assumed that a firm's managerial incentive chosen by its owner represents a linear combination of its sales and its profits and showed that owners of duopolistic firms always give incentives sales more than profit. We, however, assume that this incentive is either its sales or its profits instead. That is, we consider the situation in which a firm's managerial incentive is its sales (its profits) when the owner delegates (does not delegate) its tasks to its manager. While this assumption is certainly restrictive, it allows us to generate an equilibrium with *asymmetric* behaviors of firms, that is, one firm chooses delegation while another selects no delegation in the equilibrium, and is supported by empirical evidence in McGuire, Chiu, and Elbing (1962) and Amihud and Kamin (1979). While Brander and Lewis (1986) assumed that a firm finances a fixed start-up or project cost, we assume that it finances to pay for variable production costs, following Povel and Raith (2004). Cleary et al. (2007) empirically supported this assumption by Povel and Raith (2004), which makes our model tractable.

We consider a two-stage duopoly game with demand uncertainty. In the first stage, shareholders of each firm simultaneously choose the mode of delegation by designing an incentive scheme for the manager of their firm, either *no strategic delegation* (profit-maximization) or *strategic delegation* (sales-maximization). Of course, this seems to be too strong an assumption since incentive schemes for the manager taking into consideration components other than the profit or sales of each firm, are also considered theoretically, and data on these cannot be observed by economists in a real economy[9]. The profits or sales of companies are often open to public, via financial statements in capitalist nations. As such, we might be able to verify the theoretical model by empirical

[9]Robert Porter pointed this out in an earlier version of his paper.

analysis[10]. In the second stage, the manager of each firm simultaneously chooses her output quantity after she observes the objective of her rival firm. That is, in the second-stage game, following the Brander–Lewis framework, we first consider three types of à la Cournot duopolies with demand uncertainty: one composed of firms with no strategic delegation, one composed of firms with strategic delegation, and one mixed-delegation-type duopoly in which a no delegation firm and a delegation firm coexist. We derive a subgame perfect equilibrium of the game. We show that *both* firms choose *delegation* when the demand is *sufficiently large* but they choose *different modes of delegation* (one firm chooses no delegation and the other chooses delegation) when the demand is *small* in the equilibrium of the game. By comparing the equilibria of subgames, we characterize the equilibrium outputs, prices, and total outputs in these equilibria.

Furthermore, we define the expected social welfare in equilibria and compare its level under the three subgame equilibria previously derived. Using the demand, we characterize which of the three subgame equilibria would be desirable from a social welfare perspective. We find that a *delegation* duopoly equilibrium is most desirable from a social welfare perspective for *any* value of the demand parameter in the whole game. However, it can be attained when potential demand is *sufficiently large* but it cannot be attained as an equilibrium when the demand is *small*.

In the next section, we describe the structure of our model. In section 3, we consider a

[10]These analytical frameworks seem to be supported by McGuire, Chiu, and Elbing (1962). They present the average correlation coefficients for executive compensation and sales and for executive compensation and profits from the data on revenues, profits, and compensation for 45 enterprises from 1953 to 1959; they then show that the former is larger than the latter and that the significance of the t values for the former is consistently higher than those for the latter. Harimaya, Ohkawa, Okamura, and Shinkai (2012) focus on oligopolistic behavior in the domestic loan market and examine the intensity with which managers attempt to maximize sales and profits using data for Japanese regional banks for FY1980–FY2009. We find that sales-maximization explains the behavior of Japanese regional banks more adequately and appropriately than profit-maximization. In particular, yearly fluctuations in the degree of managerial objectives suggest that the effort to maximize sales has intensified after full-scale liberalization of interest rates.

Cournot duopoly subgame comprising two firms with no strategic delegation and derive an equilibrium of this subgame. Then, we derive a Cournot equilibrium in a duopoly subgame comprising two firms with strategic delegation. We derive a Cournot equilibrium in a mixed-type duopoly subgame comprising *a firm without strategic delegation* and *another with strategic delegation*. Furthermore, we consider the first stage, in which each firm chooses the mode of delegation (its objective)—either strategic delegation or no strategic delegation—and derive a subgame perfect equilibrium of the whole game by combining it with the three two-stage Cournot duopoly subgames. We develop a two-stage duopoly game in which each firm chooses the mode of delegation: either no strategic delegation or strategic delegation in the first stage and then à la Cournot competition in the second stage. In section 4, we evaluate the equilibrium of the whole game from a social welfare perspective. The final section contains our conclusion.

2 The Model

We consider a duopoly model in which two indebted firms produce a homogeneous good with an identical constant marginal cost. There exists additive demand uncertainty. The objective of each firm is to maximize the expected profit or sales, based on their choice. They delegate their decision of the firm's output to a manager; however, they control the manager by designing incentives to attain their objective: profit- or sales-maximization.

Fershtman and Judd (1987) assumed that the manager of firm i in an oligopolistic market is given an incentive to maximize $\alpha_i \pi_i + (1-\alpha_i) R_i$, where π_i and R_i are the profit and revenue of firm i, respectively, and α_i is the weight assigned to the profit of the manager's incentive. They showed that the shareholders of each firm always incentivize sales more than profit (i.e., a small $\alpha_i < 1$) for their manager at the equilibrium under some

conditions. Vickers (1985) also presented an example in which shareholders strategically adjust their manager's incentive different from profit-maximizing[11].

We thus restrict our attention to two polar cases—$\alpha_i = 0$ (sales maximization) and $\alpha_i = 1$ (profit maximization)—because the profit and sales of each firm are observable (known) to the other firm[12]. The shareholders can ask for debt D_i $(i = 1, 2)$ from outside investors if the equity capital is not sufficient to finance production. According to Brander and Lewis (1986), the debt holders are residual claimants in case of bankruptcy. In this paper, we consider *the strategic delegation effect* on duopolistic competition and its market outcome.

Suppose that each firm can choose its mode of strategic delegation—*strategic delegation* (sales-maximization) and *no strategic delegation* (profit-maximization)—in the first stage. Then, given the mode of delegations, two firms compete à la Cournot in the second stage.

The inverse demand function is assumed to be linear with an additive uncertainty:

$$p = a + \widetilde{z} - Q = a + \widetilde{z} - (q_1 + q_2), \tag{1}$$

where $a(> 3)$ denotes the magnitude of the market and $\widetilde{z}$ is a uniformly distributed random variable with support $[-\overline{z}, \overline{z}]$ (where $a - \overline{z} > 0$) and with probability density

[11] Vickers (1985) assumed that the manager of oligopolistic firm i maximizes $M_i = \pi_i + \theta_i q_i$, where π_i, q_i, and θ_i are profit, quantity of output, and a strategic parameter variable on the incentive for the manager of firm i.

[12] Suppose that we set $\theta_i = c$ or $\theta_i = 0$ in the objective of firm i's manager function with constant returns-to-scale technology. M_i is given by $\pi_i + \theta_i q_i = (p(Q) - (c - \theta_i))\, q_i$.

Then ,Vickers (1985)'s example reduces to the cases $\alpha_i = 0$ (sales-maximization) and $\alpha_i = 1$ (profit-maximization), respectively.

function

$$\phi(z) = \frac{1}{2\overline{z}}, \text{ for } z \in [-\overline{z}, \overline{z}], \tag{2}$$
$$= 0, \quad \text{otherwise.}$$

From (2), we observe that $\widetilde{z}$ has mean 0 and variance $\frac{1}{3}\overline{z}^2$. We also assume that firm i $(= 1, 2)$ has a linear cost function

$$C_i(q_i) = cq_i, a > c > 0.$$

We normalize $c = 1$. Here, we make a key assumption in our analysis of leveraged firms under limited liability. That is, we assume that firms are financially constrained and must finance all or part of their variable costs by borrowing from their investors or banks, following Povel and Raith (2004). Most of the debt contract literature assumes that a firm or an entrepreneur must finance a fixed start-up or project cost, as Brander and Lewis (1986) assumed in their paper. In these papers, the equilibrium output and the equilibrium debt level of each firm are not derived explicitly on account of the nonlinearity of the reaction function of each firm as described in the analysis of the Brander–Lewis framework[13]. Povel and Raith (2004), however, have considered a Cournot duopoly in which one of the firms is financially constrained and must finance all or part of its variable costs by borrowing from investors and in which another firm is not financially constrained[14].

[13] In the Brander–Lewis framework, R^i (the gross profit function) is assumed to depend on outputs q_i, q_j and random shock $\widetilde{z_i}$ with support $[-\overline{z}, \overline{z}]$. A threshold value of realization z of $\widetilde{z_i}$, $\widehat{z_i}$, is also assumed such that the firm is bankrupt for $z_i < \widehat{z_i}$ and that equity holders are residual claimants only in the good state of nature $(z_i \geq \widehat{z_i})$. Then, the value of $\widehat{z_i}$ depends not only on the debt level of B_i, but also on q_i and q_j. Therefore, the reaction function of a firm with respect to q_i becomes a nonlinear function of q_i. For example, see Franck and Pape (2008).

[14] As Povel and Raith (2004) stated in their paper, "internal funds" denotes the firm's own funds that it can use to pay for variable production costs, $w_0 \equiv r_0 - F$, where r_0 and F denote the firms retained earnings and fixed costs, respectively. Cleary et al. (2007) show that $w_0 < 0$, that is, *negative internal*

Under their assumption, the choice of output of each firm uniquely determines its level of debt, thus making our analysis more tractable. We thus assume that the debt level of each firm is a linear cost function of the firm's output under limited liability. We take the debt assumed by the firm as endogenous. The firm takes on debt only to finance its production:

$$D_i = C_i(q_i) = cq_i = q_i.$$

The profit of firm $i(= 1, 2)$ is defined as

$$\pi_i(q_i, q_j, \widetilde{z}) = R_i(q_i, q_j, \widetilde{z}) + D_i - C_i(q_i) - r = (a + \widetilde{z} - q_i - q_j)q_i - r. \tag{3}$$

When firm $i(= 1, 2)$ chooses its mode of strategic delegation—*strategic delegation* (sales-maximization)—it maximizes the *expected total net revenue* that includes its debt revenue from investors (bankers) defined as

$$R_i^{tnet}(q_i, q_j) \equiv E_{\widetilde{z}}[R_i(q_i, q_j, \widetilde{z})] = R_i(q_i, q_j, \widetilde{z}) + D_i - r = (a + \widetilde{z} - q_i - q_j + 1)q_i - r. \tag{4}$$

The repayment function is defined by

$$r = (1 + \tau)D_i = (1 + \tau)C_i(q_i) = (1 + \tau)q_i, \quad \text{if } -\overline{z} \leq z < \overline{z}, \tag{5}$$

where $\tau > 0$ is an interest rate that banks(investors) charge to every firm and assume that it is exogenously given constant in this study.

From (5), the expected profit of firm i, the expected value of profit with respect to $\widetilde{z}$, is given by (3), that is,

funds, are empirically relevant using 20 years of annual Compustat data, and as such, we can expect that a firm must finance variable costs in such cases. Hence, we think that the role of a risky debt contract on product rivalry in a duopoly under assumptions made in Povel and Raith (2004) merits investigation.

$$\begin{aligned}\pi_i(q_i, q_j) &= E_{\widetilde{z}}\left[\pi_i^U(q_i, q_j, \widetilde{z})\right] = \int_{-\overline{z}}^{\overline{z}} \left(R_i(q_i, q_j, z) - C_i(q_i) + D_i - r\right)\phi(z)dz \\ &= \int_{-\overline{z}}^{z} (a + z - q_i - q_j - (1+\tau))q_i\phi(z)dz. \qquad (6)\end{aligned}$$

We assume the following to guarantee a positive margin for the firms in an equilibrium.

[**Assumption 1**] $a > 3 + \tau$.

3 Two-stage Game under Unlimited Liability

We first derive the second-stage duopoly game in which firms choose the mode of delegation, either no delegation (profit-maximization) or delegation (sales-maximization), in the first stage, and then compete à la Cournot in the second stage.

We now consider the second-stage game. Given that each firm chooses no delegation as its mode of delegation, we have an equilibrium in the Cournot duopoly game.

From (6) in section 2, the first-order condition is given by

$$a - 2q_i^N - q_j^N - 1 - \tau = 0, i, j = 1, 2, \qquad (7)$$

where superscript N denotes that the mode of delegation for each firm is *no delegation*.

From (7), (1), (1), and (3), we can easily obtain each firm's output, total output, and expected price, the firms' expected profits, the expected producer surplus, the expected consumer, and the expected social surplus at the equilibrium. These are summarized in Table 1.

Next, given that each firm chooses delegation as its mode of delegation, a simple calculation gives us the Cournot equilibrium. Each firm i maximizes its expected net

revenue from (4) and (5):

$$\begin{aligned} R_i^{tnet}(q_i, q_j) &= \max_{q_i} E_{\widetilde{z}}[(a + \widetilde{z} - q_i^D - q_j^D + 1)q_i^D - r] \\ &= \max_{q_i}\{(a + \widetilde{z} - q_i^D - q_j^D - \tau)q_i^D\}, \end{aligned}$$

where superscript D denotes that the mode of delegation for each firm is *delegation*.

The first-order condition is

$$a - 2q_i^D - q_j^D - \tau = 0, i, j = 1, 2. \tag{8}$$

From (8), (1), and (3), we can easily obtain each firm's output, the total output, the expected price, the firms' expected profits, the expected producer surplus, the expected consumer surplus, and the expected social surplus at the equilibrium. These are summarized in Table 1.[15]

Finally, we examine the *mixed-delegation* Cournot duopoly, in which one firm (say, firm 1) adopts *no delegation* (profit-maximization) while the other (say, firm 2) adopts *delegation* (sales-maximization). We use the *superscript* ND to denote the variables associated with the Cournot duopoly in which firm 1 adopts *No delegation* (profit-maximization) while the other (say, firm 2) adopts *Delegation*.

Setting $i = 1, j = 2$ in (7) and $i = 2, j = 1$ in (8) yields

$$\begin{aligned} a - 2q_1^{ND} - q_2^{ND} - 1 - \tau &= 0, \\ a - 2q_2^{ND} - q_1^{ND} - \tau &= 0, \end{aligned} \tag{9}$$

where superscript ND shows that the mode of delegation of firm 1 (firm 2) is *No delegation*

[15] To guarantee a positive expected profit in the UD equilibrium, we assume that $a > 3$.

(*Delegation*).

From (9), (1), and (3), we can easily obtain each firm's output, the total output, the expected price, and the firms' expected profits at the ND equilibrium. These are summarized in Table 1.

Note that $a-\tau > 3$ guarantees the existence of the mixed-delegation equilibrium. We can easily show the following proposition from Proposition 1.

Proposition 1 Suppose that $a - \tau > 3$. Then, we have $q_2^{ND} > q_i^D > q_i^N > q_1^{ND}$, $Q^D > Q^{ND} > Q^N$, and $Ep^D < Ep^{ND} < Ep^N$. If $a-\tau \geq 4$, then $E\pi_2^{ND} > E\pi_i^N \geq E\pi_i^D \geq E\pi_1^{ND}$. If $3 < a - \tau < 4$, then $E\pi_2^{ND} > E\pi_i^N > E\pi_1^{ND} > E\pi_i^D$, $i = 1, 2$.

The intuition underlying this proposition is clear. The *delegation* (sales-maximizer) firm in the D *equilibrium* produces more aggressively than the *no delegation* (profit-maximizer) firm in the N *equilibrium* because the former acts without considering its cost. This result intrinsically corresponds to the result presented in Fershtman and Judd (1987). In the ND mixed-delegation type duopoly equilibrium, in addition to no consideration on cost, the strategic substitute property in Cournot competition makes the *delegation* (sales-maximizer) firm 2 act more aggressively, and accordingly, the *no delegation* (profit-maximizer) firm 1 reacts by shrinking its output as compared to in the N equilibrium.

The last inequality result of the above proposition explains why Suzuki & Co. (*no delegation* (profit-maximizer) firm) never delegated managerial decisions when its rival Mitsui Gomei Kaisya (*delegation* (sales-maximizer) firm) had done so: the potential demand in the market was not large enough in the ND mixed-delegation type duopoly equilibrium. If Suzuki & Co. had delegated, then its expected profit would have shrunk.

4 Welfare Analysis

In this section, we conduct equilibrium welfare analysis of the subgames. The expected social surplus is the sum of the net expected producer surplus, the expected surplus of the banks (investors), and the expected consumer surplus.

The net expected producer surplus in the k $(=N, D, M,$ where $M = ND \text{or} DN)$ equilibrium is expressed as

$$EPS^k = \int_{-\overline{z}}^{\overline{z}} PS^k(Q^k, z)\phi(z)dz = \frac{1}{2\overline{z}}\int_{-\overline{z}}^{\overline{z}}(a + z - Q^k - 1 - \tau)Q^k dz. \tag{10}$$

The expected profit of banks (investors) in the k equilibrium is given by

$$EBP^k = \frac{1}{2\overline{z}}\int_{-\overline{z}}^{\overline{z}}((1+\tau)Q^k - Q^k)dz = \tau Q^k, k = N, D \text{ and } M(ND \text{ or } DN). \tag{11}$$

From the above equation and Proposition 1, we see that $EBP^D > EBP^M > EBP^N = \frac{2}{3}\tau(a-1-\tau) > 0$, since $a-1 > a-3 > \tau$ from Assumption 1. Hence, there exists τ^* such that $0 < \tau^* < a-3$ and a positive expected profit for banks (investors) in the equilibrium is ensured.

The expected consumers' surplus in the k equilibrium is

$$ECS^k = \int_{-\overline{z}}^{\overline{z}} CS^k(Q^k, z)\phi(z)dz = \frac{1}{2\overline{z}}\int_{-\overline{z}}^{\overline{z}}\frac{1}{2}(Q^k)^2 dz = \frac{1}{2}(Q^k)^2. \tag{12}$$

We define the expected social surplus in the k equilibrium as

$$ESS^k = EPS^k + EBP^k + ECS^k. \tag{13}$$

Substituting (10), (11), and (12) into (13) and rearranging, we get

$$\begin{aligned} ESS^k &= \frac{1}{2\overline{z}}\int_{-\overline{z}}^{\overline{z}}(a+z-Q^k-1)Q^k dz + \frac{1}{2}(Q^k)^2 \\ &= (a-Q^k-1)Q^k + \frac{1}{2}(Q^k)^2 = (a-\frac{1}{2}Q^k-1)Q^k \equiv F(Q^k). \end{aligned} \tag{14}$$

That is, the expected social surplus in the k equilibrium is expressed by a concave quadratic function of the total output of each equilibrium.

F has a maximum at $Q^* = a-1$. Then, we have

$$F'(Q^k) \gtreqless 0, \text{ if } Q^k \lesseqgtr Q^* = a-1. \tag{15}$$

Because $E[p^k - 1] = E[a+\overline{z}-1-Q^k] = a-1-Q^k = Q^* - Q^k > 0$, $Q^* > Q^k$ holds from Proposition 1.

The expected producer surplus, the expected consumer, and the expected social surplus at each equilibrium are summarized in Table 1.

[Insert Table 1 here]

From Table 1, we can easily derive the following proposition. (The proof is omitted.)

We consider the first-stage game summarized in Table 2.

[Insert Table 2 here]

Note that $E\pi_2^{DN} = E\pi_1^{ND}$ and $E\pi_1^{DN} = E\pi_2^{ND}$. From Proposition 1and Table 2, we obtain the following propositions.

Proposition 2 Suppose that $a - \tau \geq 4$. Then, the equilibrium mode of delegation is (D, D). Suppose that $3 < a - \tau < 4$. Then, the equilibrium mode is mixed: either (D, N) or (N, D).

We compare the expected social welfare at the three equilibria derived above, and evaluate the equilibrium of the whole game from a social welfare perspective.

Proposition 3 $ESS^D > ESS^M > ESS^N$, where $M = (ND \text{or} DN)$.

Proof: From (15) and Proposition 1, We see that $ESS^k = F((Q^k))$ and $F'(Q^k) > 0$ for $Q^* = a - 1 > Q^k, \qquad k = N$, D and $M(DN$ or $ND)$, and that $Q^* = a - 1 > Q^D > Q^{ND} > Q^N$. Hence the result follows.Q.E.D.

The *delegation duopoly* is most desirable and realized as an equilibrium in the two-stage game for large demand ($a \geq 4$).

That is, the equilibrium in this case achieves the second best. On the other hand, with low demand, the resulting equilibrium fails to attain the second best.

Note that the mixed-delegation equilibrium ((D, N) or (N, D)) appears when the demand is small. Neither the lack of consideration on cost nor the strategic substitute property under Cournot competition makes the *delegation* (sales-maximizer) firm 2 act more aggressively, and accordingly, the *no delegation* (profit-maximizer) firm 1 reacts by greatly shrinking its output since the residual demand after deducting the expanding output of the *delegation* firm 2 becomes small and firm 1 must choose less aggressively mode, *no delegation*. Thus, the mixed-delegation equilibrium may be attained at least when the potential demand is small. However, the owners of firm 1 choose *delegation* instead of *no delegation* if the potential demand is large enough, if they expect that residual demand after deduction of the expanding output of the *delegation* firm 2 is sufficiently low, and if the *delegation equilibrium* (D, D) may be attained.

From the result derived in this section, note that the *mixed-delegation* duopoly prevails as an equilibrium when the demand is small, but the delegation duopoly prevails when this demand becomes large. Thus, managerial incentives more weighed to profits may prevail when potential demand is small and efficient delegation duopoly is not always seen in the equilibrium.

5 Conclusion

In this article, we consider a duopoly with additive demand uncertainty in which there are two firms producing and supplying a homogeneous good with an identical constant returns-to-scale technology. We consider no delegation and delegation, two opposite types of incentive contracts, one of which attaches great importance to *profit* and another places less emphasis on profit but more on *sales*. First, we derive a two-stage duopoly game in which shareholders of each firm choose the mode of delegation, either *no delegation* (profit-maximization) or *delegation* (sales-maximization), in the first stage and then compete à la Cournot in the second stage. By deriving a subgame perfect equilibrium in this two-stage game, we show that the *mixed-delegation* duopoly arises as a subgame perfect equilibrium when potential demand is small and the *delegation* duopoly arises as an equilibrium when potential demand is large. Furthermore, we show that the *delegation duopoly* is always the most efficient from a social welfare perspective.

From the results of the two-stage game in Proposition 1, we present a rational illustration why Suzuki & Co. (*no delegation* (profit-maximizer) firm) never delegated managerial decision-making even when rival Mitsui Gomei Kaisya (*delegation* (sales-maximizer) firm) did so: the potential demand in the market was not large enough in the mixed-delegation type duopoly equilibrium in Taisho Japan. Thus, if Suzuki were

to managerially delegate, its expected profit would have likely decreased.

In the paper, we consider the effect of strategic delegation on equilibrium outcome and welfare only in a Cournot duopoly with a strategic substitute model structure. The result on welfare, of course holds only for the scenario in which the moral hazard problem never exists, as is the case for this work. In the real business world, lenders (banks) take precautions to ensure that their money is not squandered or put at unnecessary risk by those who have borrowed it, because there exists the moral hazard problem of borrowers. That is, they monitor what they lend by examining the firm's financial condition and credit history and by placing restrictions on how their funds may be used. Our analysis ignores this moral hazard problem and thus also ignores such monitoring activities of investors. The results of this welfare analysis may differ if the analysis considers the moral hazard problem.

Accordingly, many issues remain. The first issue to address is the extension of our analysis to an oligopoly setting. The second one to address is our analysis under limited liability and comparison of it with the result of this analysis. Furthermore, as Etro (2012) emphasized in his paper, it is important to consider the relationship between strategic delegation and limited liability in price competition with strategic complementarity. This issue is left for future research.

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References

[1] **Amihud, Y. and J. Kamin**, "Revenue vs. Profit Maximization: Differences in Behavior by the Type of Control and by Market Power," *Southern Economic Journal*, 1979, 45, 838-846.

[2] **Baumol, W. J.**, "On the Theory of Oligopoly," *Economica*, 1958, 25, 187-198.

[3] **Brander, J. A. and T. R. Lewis**, "Oligopoly and Financial Structure: The Limited Liability Effect," *American Economic Review*, 1986, 76, 956-970.

[4] **Cleary S., P. Povel, and M. Raith**, "The U-shaped Investment Curve: Theory an Evidence," *Journal of Finance and Quantitative Analysis*, 2007, 42, 1-40.

[5] **Etro, F.**, "Endogenous Market Structures and the Optimal Financial Structure," *Canadian Journal of Economics/Revue Canadienne d'Economique*, 2010, 43, 1333-1352.

[6] **Fershtman, C. and K. L. Judd**, "Equilibrium Incentives in Oligopoly," *American Economic Review*, 1987, 77, 927-940.

[7] **Franck, B. and N. L. Pape**, "The Commitment Value of the Debt: A Reappraisal," *International Journal of Industrial Organization*, 2008, 26, 607-615.

[8] **Harimaya, K., T. Ohkawa, M. Okamura, and T. Shinkai**, "Sales-Maximization vs. Profit-Maximization: Managerial Behavior at Japanese Regional Banks 1980-2009," Discussion Paper Series No. 94, School of Economics, Kwansei Gakuin University, Nishinomiya, 16 pages, 2012.

[9] **Katsura, Y.**, "The Role of One Sogoshosha in Japanese Industrialization: Suzuki & Co., 1877–1927," *Proceedings of the Business History Conference*, 32-61.1975, http://www.thebhc.org/publications/BEHprint/v03/katsura.pdf.

[10] **McGuire, J. W., J. S. Chiu, and A. O. Elbing**, "Executive Income, Sales and Profits," *American Economic Review*, 1962, 52, 753-761.

[11] **Neff, C.**, *Corporate Finance, Innovation and Strategic Competition*, Springer-Verlag, Berlin, 2003.

[12] **Povel, P. and M. Raith**, "Financial Constraints and Product Market Competition: Ex-ante vs. Ex-post Incentives," *International Journal of Industrial Organization,* 2004, 22, 917-949.

[13] **Roberts, J.**, *Mitsui—Three Centuries of Japanese Business*, Weatherhill, Inc., New York and Tokyo, 1973.

[14] **Sengul, M., J. Gimeno, and J. Dial**, "Strategic Delegation: A Review, Theoretical Integration, and Research Agenda," *Journal of Management*, 2012, 38, 375-414.

[15] **Spulber, D. F.**, *Famous Fables in Economics–Myths of Market Failures–*, Eds. by D. F. Spulber, Blackwell Publisher, Malden, Massachusetts, 2002.

[16] **Vickers, J.**, "Delegation and Theory of the Firm," *The Economic Journal*, 1985, 95, 138-147.

Table 1 Subgame Equilibrium

N equilibrium	ND equilibrium	D equilibrium
$q_i^N = \frac{1}{3}(a-\tau)$	$q_1^{ND} = \frac{1}{3}(a-\tau-2) < q_2^{ND} = \frac{1}{3}(a+1-\tau)$	$q_i^D = \frac{1}{3}(a-\tau-1)$
$Q^N = \frac{2}{3}(a-\tau-1)$	$EQ^{ND} = \frac{1}{3}(2(a-\tau)-1)$	$Q^D = \frac{2}{3}(a-\tau)$
$Ep^N = \frac{1}{3}(a+2(1+\tau))$	$Ep^{ND} = \frac{1}{3}(a+2\tau+1)$	$Ep^D = \frac{1}{3}(a+2\tau)$
$E\pi_i^N = \frac{1}{9}(a-\tau-1)^2$	$E\pi_1^{ND} = \frac{1}{9}(a-\tau-2)^2$ $< E\pi_2^{ND} = \frac{1}{9}(a-\tau-2)(a+1-\tau)$	$E\pi_i^D = \frac{1}{9}(a-\tau)$ $\times(a-\tau-3)$
$EPS^N = \frac{2}{9}(a-\tau-1)^2$	$EPS^{ND} = \frac{1}{9}(a-\tau-2)$	$EPS^D = \frac{2}{9}(a-\tau)$
	$\times(2(a-\tau)-1)$	$\times(a-\tau-3)$
$ECS^N = \frac{2}{9}(a-\tau-1)^2$	$ECS^{ND} = \frac{1}{18}(2(a-\tau)-1)^2$	$ECS^D = \frac{2}{9}(a-\tau)^2$
$ESS^N = \frac{4}{9}(a-\tau-1)^2$	$ESS^{ND} = \frac{1}{18}(2(a-\tau)-1)$	$ESS^D = \frac{2}{9}(a-\tau)$
	$\times(4(a-\tau)-5)$	$\times(2(a-\tau)-3)$

E denotes the expected value of PS, CS, and SS denote producers' surplus, consumers' surplus, and social surplus in each equilibrium, respectively.

Table 2 First-stage game

Firm 1\Firm 2	N	D
N	$E\pi_1^{UN}, E\pi_2^{UN}$	$E\pi_1^{UND}, E\pi_2^{UND}$
D	$E\pi_1^{UDN}, E\pi_2^{UDN}$	$E\pi_1^{UD}, E\pi_2^{UD}$

N and D denote *no delegation* and *delegation*, respectively.