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Upstream collusion and downstream managerial incentives

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ABSTRACT

We investigate the effects of downstream firms' managerial incentives on upstream collusion. Downstream profit-and-revenue incentive schemes make upstream manufacturers easier to collude than a pure-profit incentive scheme does when retailers compete in prices. However, the opposite occurs under quantity competition.

1. Introduction

Due to the separation of management and ownership, retail stores owners often design incentive contracts and delegate competitive strategies (price or quantity decisions) to their managers. It is common that store owners base their managers' salaries upon sales besides profits (Mujumdar and Pal, 2007). Since Fershtman (1985), a vast amount of research has been conducted on incentive design, whereas our focus is on the role of managerial incentives in the stability of upstream collusion. Tacit collusion is subtle in regulation due to its implicitness, and has been widely studied. However, research on collusion in vertical settings is a recent trend (Nocke and White, 2007; Normann, 2009; Piccolo and Reisinger, 2011).

Motivated by practical observations and ongoing research, we investigate the effects of downstream managerial delegation on upstream collusion. Specifically, we answer two research questions. How do downstream managerial incentives affect upstream collusion? What are the effects of competition modes on the role of managerial incentives?

To this end, a simple repeated game is developed. We find profit-and-revenue incentive (mixed incentive, hereafter) may facilitate or hinder upstream collusion, depending on whether the retailers compete in prices or quantities. Mixed incentives have two opposing effects on upstream collusion under each competition mode and the direction of these effects depends crucially on the nature of downstream competition. Specifically, under price competition, mixed incentive makes deviation less profitable, which dampens collusion, but it also causes less severe punishment that favors collusion. In contrast, under quantity competition, deviation is more profitable, while punishment for deviation is also of higher severity. The works by Lambertini and Trombetta (2002) and Spagnolo (2005) are related to ours. However, unlike their horizontal setting, we examine the collusive effects of managerial incentives in a vertical framework. Furthermore, although the more recent research by Nocke and White (2007), Normann (2009) and Piccolo and Reisinger (2011) consider tacit collusion in vertical channels, they do *not* consider managerial incentives, the focus of our research.

2. Model with downstream price competition

There are two manufacturers (manufacturers 1 and 2) distributed through two exclusive retailers (retailers 1 and 2). Each retailer comprises an owner i and a manager i ($i = 1, 2$). Following

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Singh and Vives (1984), we employ the following inverse demand:

$$p_i\left(q_i, q_j\right) = a - q_i - \theta q_j, \quad i, j = 1, 2;\ i \neq j, \tag{1}$$

where a is the market potential and $\theta \in [0, 1]$ reflects product substitutability.

Inverting (1), we obtain the demand system as

$$q_i\left(p_i, p_j\right) = \frac{(1-\theta)\,a - p_i + \theta p_j}{1-\theta^2}, \quad i, j = 1, 2;\ i \neq j. \tag{2}$$

In the following, we adopt the standard approach by using (1) under downstream quantity competition and (2) when price competition occurs.

Following Fershtman (1985), we assume both owners design incentives based either on (i) pure profit (a pure-profit incentive), or (ii) both profit and revenue (a mixed incentive). Thus, manager i's salary is $\alpha_i\left(p_i - w_i\right) q_i\left(p_i, p_j\right)$ under pure-profit incentive, and $\alpha_i\left[\left(p_i - w_i\right) q_i\left(p_i, p_j\right) + \lambda_i p_i q_i\left(p_i, p_j\right)\right]$ under mixed incentive, where α_i is a scaling parameter and w_i is manufacturer i's wholesale price. We assume each manager has zero opportunity cost and each manufacturer's marginal cost, without loss of generality, is assumed to be zero.

Suppose an infinitely repeated game with discrete time periods. In each period a multi-stage game is played. In the first stage, the manufacturers simultaneously set their wholesale prices. In the second stage, the owners compete by choosing their incentive parameters (the owner adopting pure-profit incentive is idle here). The managers non-cooperatively decide products' prices (or quantities) in the third stage. We justify the above sequence as follows. Assuming the existence of incentive type is reasonable in that the retailer's incentive type (pure-profit or mixed) does not change for strategic concerns (Zábojník, 1998; Mujumdar and Pal, 2007), which is consistent with practice, while the value of incentive parameter (the revenue weight λ_i) is less strategic and hinges on the manufacturers' wholesale prices. Two downstream incentive structures are considered:

(i) Incentive scheme P (or pure-profit incentive scheme). Both owners employ pure-profit incentives.
(ii) Incentive scheme R (or mixed incentive scheme). Both owners design mixed incentives by concerning both profits and sales revenue.

We use *the following superscripts* to indicate various scenarios, with

$i = p, q$ denotes downstream price and quantity competition, respectively.
$j = P, R$ indicates downstream incentive schemes P, R, respectively.
$k = N, C, D$ represents non-collusive, collusive, and deviation at the manufacturer level, respectively.

To keep the article concise, we abstract from other possible scenarios, which are left for future research.

2.1. Incentive scheme P

We first consider the scenario for incentive scheme P, where manager i's problem is

$$\operatorname*{Max}_{p_i} \Pi_{R_i} = \alpha_i\left(\left(p_i - w_i\right) q_i\left(p_i, p_j\right)\right), \quad i, j = 1, 2;\ i \neq j. \tag{3}$$

The subscript 'R_i' denotes manager i. Solving the first-order conditions (FOCs) from (3), we obtain

$$p_i\left(w_i, w_j\right) = \frac{(2+\theta)(1-\theta)\,a + 2w_i + \theta w_j}{4-\theta^2}, \quad i, j = 1, 2;\ i \neq j. \tag{4}$$

From (4), we see that, under the full symmetric case ($w_i = w_j$) and when both products are perfect substitutes ($\theta = 1$), the retail price falls to marginal cost ($p_i = w_i$), which is a standard result under Bertrand competition.

Now we consider three possible interactions at the manufacturers' level: punishment, collusion and deviation. First, we consider the punishment stage, where the two manufacturers set their wholesale prices non-collusively. Therefore, manufacturer i's punishment-stage problem is

$$\operatorname*{Max}_{w_i} \Pi_{Mi}\left(w_i, w_j\right) = w_i q_i\left(p_i\left(w_i, w_j\right), p_j\left(w_j, w_i\right)\right), \quad i, j = 1, 2;\ i \neq j. \tag{5}$$

The subscript 'Mi' indicates manufacturer i. Plugging (4) into (5), we derive the wholesale price and profit as

$$\begin{cases} w_i^{pPN} = \dfrac{\left(2-\theta-\theta^2\right) a}{4-\theta-2\theta^2} \\ \Pi_{Mi}^{pPN} = \dfrac{(1-\theta)(2+\theta)\left(2-\theta^2\right) a^2}{(1+\theta)(2-\theta)\left(4-\theta-2\theta^2\right)^2}. \end{cases} \tag{6}$$

Next, we consider the collusion stage where two manufacturers collude in setting wholesale prices. Thus, manufacturer i's problem is to maximize

$$\operatorname*{Max}_{w_i} \sum_{i,j=1,2;\ i\neq j} \Pi_{Mi}\left(w_i, w_j\right), \tag{7}$$

where $\Pi_{Mi}\left(w_i, w_j\right)$ given by (5) and (4) still holds as downstream response functions. By differentiation, we solve manufacturer i's wholesale price and profit as

$$\begin{cases} w_i^{pPC} = \dfrac{a}{2} \\ \Pi_{Mi}^{pPC} = \dfrac{a^2}{4(1+\theta)(2-\theta)}. \end{cases} \tag{8}$$

Finally, suppose manufacturer i intends to deviate, and the other manufacturer cannot detect it until the next period, from which the deviant manufacturer will be punished forever. Thus, manufacturer i maximizes its own profit, provided manufacturer j sticks to the collusion, namely,

$$\operatorname*{Max}_{w_i} \Pi_{Mi}\left(w_i, w_j^{pPC}\right), \quad i, j = 1, 2;\ i \neq j, \tag{9}$$

where w_j^{pPC} is given by (8). Differentiating (9), we derive the deviant manufacturer's wholesale price and profit as

$$\begin{cases} w_i^{pPD} = \dfrac{\left(4-\theta-2\theta^2\right) a}{4\left(2-\theta^2\right)} \\ \Pi_{Mi}^{pPD} = \dfrac{\left(4-\theta-2\theta^2\right)^2 a^2}{16\left(1-\theta^2\right)\left(2-\theta^2\right)\left(4-\theta^2\right)}. \end{cases} \tag{10}$$

Based on infinite Nash reversion, we determine the standard critical discount factor δ^{pP}, above which the upstream collusion is sustained. Following Piccolo and Reisinger (2011), we have

$$\delta^{pP} = \frac{\left(4-\theta-2\theta^2\right)^2}{32 - 16\theta - 31\theta^2 + 8\theta^3 + 8\theta^4}. \tag{11}$$

2.2. Incentive scheme R

Now consider the mixed incentive case. Manager i's problem under incentive scheme R is given by

$$\operatorname*{Max}_{p_i} \Pi_{R_i} = \alpha_i\left[\left(p_i - w_i\right) q_i\left(p_i, p_j\right) + \lambda_i p_i q_i\left(p_i, p_j\right)\right]_i, \quad i, j = 1, 2;\ i \neq j. \tag{12}$$