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Cross Ownership and Licensing Incentive

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A B S T R A C T

In a homogeneous good Cournot duopoly, a firm owns a cost-reducing technology and shares his ownership to its rival. We show that optimal output of firm 1 is lower under licensing than under no licensing but optimal output of firm 2 is higher under licencing than under no licensing. Superior firm will license its superior technology to firm 2 depends on how effective the technology is.

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INTRODUCTION

Passive partial ownership (PPO) holding is the situation when firm owns a non-controlling minority share of its rival. There are many literatures show the passive partial ownership. Boyana and Lopez (2018) point out that PPO may beneficially effects on market outcomes and welfare. Ghosh and Morita (2017) consider firms choosing to transfer their technology either via PPOs or via licensing under royalties.

LITERATURE REVIEW

Papadopoulos et al (2019) analyze the product innovation transfer under passive partial ownership holding. They show that technology transfer increases aggregate output, industry-wide profits, consumers surplus, and social welfare. Leonardos et al (2021) examine partial passive ownership holding and licensing. PPO induces licensing via a fixed fee and increases consumer surplus and social welfare.

This paper wants to examine the cross ownership between firm 1 and firm 2 through passive partial ownership by assuming that firm 1 has a superior technology. We consider fixed fee licensing as it is in Leonardos et al (2021) because there is substantial evidence that fixed fees are common in many real-world markets. Ghosh and Morita (2017) mention that knowledge is often classified into tacit and explicit knowledge. Explicit knowledge can be transferred through licensing and contracting because it is verifiable. For instance, they are used in short-term licensing (Mendi, 2005), when licensing has a high potential of follow-up innovations (Yanagawa and Wada, 2000).

We find that firm 2's output is higher under licensing that under no licensing. This is due to the lower cost after licensing. Firm 1's output, however, is lower under licensing than under no licensing. This is due to the sharing ownership and licensing.

This paper is organized as follows. Section 2 outlines the model. The main results are presented in section 3. Finally, section 4 concludes this paper.

METHODOLOGY

We consider a homogeneous good Cournot duopoly. Firms face an inverse linear demand, $p = \alpha - Q$, where $Q = q_1 + q_2$. Firm 2 has a production technology with marginal cost c > 0. Firm 1 owns a superior technology and produces with marginal cost $c - e$, where $e \in (0, c)$ is the marginal cost reduction induced by the technology. Firm 1 and firm 2 have cross partial passive ownership holdings (PPOs) over one each other, owning a share $k_i \in (0, \frac{1}{2}]$.

Firms engage in a two-stage game. In stage 1, firm 1 decides whether to license its superior technology to firm 2 via a fixed fee F ≥ 0. In stage 2, firms compete in quantities. The firms' net profits are:

RESEARCH RESULT AND DISCUSSION

No Technology Licensing

The objective functions of both firms are given as follows :

$$\pi_1 = (1-k_1)(p-c+e)q_1 + k_2(p-c_2)q_2, \tag{1a}$$

$$\pi_2 = (1-k_2)(p-c_2)q_2 + k_1(p-c+\varepsilon)q_1. \tag{1b}$$

We assume, the marginal cost of firm 2 is $c_2 = c$. Maximizing (1a) and (1b) with respect to quantity and solving them simultaneously. The optimal outputs are given by :

$$q_1 = -\frac{\big((c-\alpha)k_2+(k_1-1)(c-2e-\alpha)\big)(k_2-1)}{(k_2+k_1-1)(k_2+k_1-3)}, \tag{2a}$$

$$q_2 = -\frac{((c-e-\alpha)k_2+(k_2-1)(c+e-\alpha))(k_1-1)}{(k_2+k_1-1)(k_2+k_2-3)}. \tag{2b}$$

Substituting (3a) and (3b) into profit function (1), the profits are given by :

$$\pi_1 = \frac{1}{((k_2+k_1-1)(k_2+k_1-3)^2}(((4+k_2^2+(k_1-5)k_2)(k_1-1)e^2-(4+k_2^2+(k_1-5)k_2)(k_2+k_1-1)(c-\alpha)e+(c-\alpha)^2(k_2+k_1-1)(k_1-1), \tag{3a}$$

$$\pi_2 = \frac{1}{((k_2+k_1-1)(k_2+k_1-3)^2}(((-k_1^3+(-k_2-5)k_1^2-3k_1+k_2-1)e^2+(2+k_1^2+(k_2-5)k_1(k_2+k_1-1)(c-\alpha)e+(c-\alpha)^2(k_2+k_1-1)(k_1-1). \tag{3b}$$

The next section is discussing the licensing part.

Technology Licensing

Under licensing, firm's marginal costs are equal ($c_1 = c_2 = c - e$). We substitute the marginal cost into the profit function in (1) and maximize them with respect to its own output. After solving the reaction functions simultaneously, we obtain the following optimal outputs

$$q_1^L = \frac{(k_2-1)(\alpha-c+e)}{k_1+k_2-3}, \tag{4a}$$

$$q_2^L = \frac{(k_1-1)(\alpha-c+e)}{k_1+k_2-3}. \tag{4b}$$

Optimal output of each firm when the firm owns its rival is increasing. This result is very intuitive. From the analysis above, we are going to discuss the case which makes us easier to interpret the results.

Case: $\boldsymbol{k_2 = 0}$ **and** $\boldsymbol{k_1 \epsilon (0, \frac{1}{2})}$ **(firm 2 owns firm 1) No licensing**

In this section we assume the less efficient firm (firm 2) owns the superior technology firm (firm 1). As we mentioned before, under no licensing, we assume that the marginal cost of firm 2 is $c_2 = c$. k is the ownership of firm 1 owned by firm 2, owning a share $k \in (0, \frac{1}{2}]$.The profit functions are

$$\pi_1 = (1-k)(p-c+e)q_1 + F, \tag{5a}$$

$$\pi_2 = (p-c_2)q_2 - F + k(p-c+e)q_1. \tag{5b}$$

Taking the first order condition of the objective functions in (5) with respect to its own output and solving them simultaneously. The optimal outputs are as follows

$$q_1^{NL} = \frac{-\alpha+c-2e}{k-3}, \tag{6a}$$

$$q_2^{NL} = \frac{(\alpha-c-2e)k+c+e-\alpha}{k-3}. \tag{6b}$$

Substituting (6) into the profit function (5) to obtain optimal profits under no Licensing.

$$\pi_1^{NL} = -\frac{(k-1)(\alpha-c+2e)^2}{(k-3)^2}. \tag{7a}$$

$$\pi_2^{NL} = -\frac{(-k^2+4k+1)e^2+(k^2-5k+2)(c-\alpha)e+(c-\alpha)^2}{(k-3)^2}. \tag{7b}$$

Case: $\boldsymbol{k_2 = 0}$ ***and*** $\boldsymbol{k_1 \epsilon (0, \frac{1}{2})}$ **(firm 2 owns firm 1) Licensing**

Substituting $c_2 = c - e$ into the profit function of firm 2 (5b) and maximize the profit functions with respect to its output. The optimal output of both firms are as follows

$$q_1^L = \frac{c-e-\alpha}{k-3}, \tag{8a}$$

$$q_2^L = \frac{(k-1)(\alpha-c+e)}{k-3}. \tag{8b}$$

Substituting (8) into (5), we obtain optimal profits as follows

$$\pi_1^L = \frac{1}{(k-3)^2}(-e(c-e-\alpha)k^2 + (-5e^2 + (7c-7\alpha)e - (c-\alpha)^2)k + e^2 +$$

$$(-6c+6\alpha)e + (c-\alpha)^2, \tag{9a}$$

$$\pi_2^L = \frac{1}{(k-3)^2}(-k^2+4k+1)e^2 + (k^2-5k+2)(c-\alpha)e + (c-\alpha)^2. \tag{9b}$$

Taking the difference between firm 2's profit after licensing and before licensing to obtain the fixed fee licensing.

$$F = -\frac{((c-e-\alpha)k-c+\alpha)e(k-4)}{(k-3)^2}. \tag{10}$$

Sharing ownership decreases the incentive of firm 1 to license its technology to firm 2. When firm 1 shares its ownership to firm 2, firm 1 profit decreases. This condition incentivizes firm 1 not to licenses its technology to firm 2.

Licensing Incentives

The following is the comparison between optimal outputs, total output, and final price under licensing and no licensing.

$$\Delta q_1 = \frac{e}{k-3}, \quad \Delta q_2 = -\frac{2e}{k-3}, \quad \Delta p = \frac{e}{k-3}, \quad \Delta Q = \frac{(2\alpha-2c+2e)k+2c+2e-2\alpha}{k-3}.$$

By comparing the equilibrium market outcomes across the non-licensing and the licensing regimes, we obtain the following results

Lemma 1: *It holds that* $q_1^L < q_1^N, q_2^L > q_2^N, Q^L > Q^N,$ *and* $p^L < p^N$

Licensing allows firm 2 to produce a higher output because: (i) Licensing lowers its marginal cost, and (ii) firm 2 owns the shares of the more superior technology firm (firm 1). Licensing intensifies competition between the firms and lead to higher total output.

In stage 1, licensing occurs only if it is profitable for firm 1, $\pi_1^L > \pi_1^{NL}$. The following proposition identifies the condition under which the licensing occurs.

Proposition 1. *Firm 1 licenses its technology to firm 2 if and only if* $k \geq k_{cr}(\varepsilon) = \frac{1}{2(\varepsilon+1)}[\varepsilon + 3 + \sqrt{13\varepsilon^2 + 10\varepsilon + 1}$.

Fig.1 illustrates Proposition 1. Fig.1 shows that the relationship between k_{cr} and ε are concave function. Firm 1 will license its superior technology to firm 2 depends on how effective the technology is. This result is different with Leonardos et al (2021) in which they find that firm 1 will always license its superior to its partially owned firm 2 if the technology is not too effective.

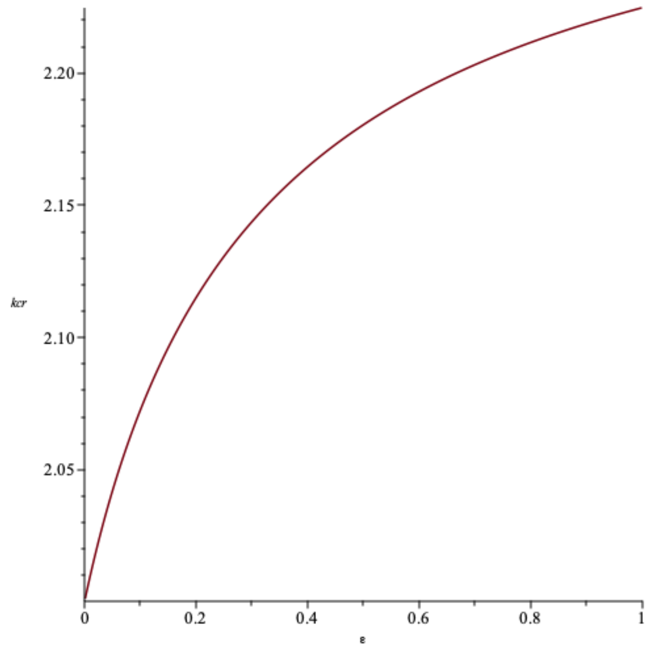

Fig. 1. Critical partial horizontal ownership $k_{cr}(\varepsilon)$.

CONCLUSIONS AND RECOMMENDATIONS

We consider a homogeneous good Cournot duopoly in which firm 1 owns a cost-reducing technology but share his ownership to firm 2 who does not have a cost-reducing technology. Licensing allows firm 2 to produce a higher output because it lowers its marginal cost. In addition, total output is higher under Licensing than under no licensing. The final price is lower under licensing than under no licensing. The incentive for firm 1 to license its superior technology to firm 2 depends on how effective the technology is.

ADVANCED RESEARCH

In writing this article the researcher realizes that there are still many shortcomings in terms of language, writing, and form of presentation considering the limited knowledge and abilities of the researchers themselves. Therefore, for the perfection of the article, the researcher expects constructive criticism and suggestions from various parties.

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