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in Economics*



**Licensing by a monopolist and
unionized labor market**

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Dresden Discussion Paper in Economics No. 09/07

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Licensing by a monopolist and unionized labor market

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Abstract:

We show that a monopolist final goods producer may find it profitable to create competition by licensing its technology if the input market is imperfectly competitive. With a centralized union, we show that licensing by a monopolist is profitable under both uniform and discriminatory wage settings by the union. However, the incentive for licensing is higher under the former situation. We also show that licensing by the monopolist is profitable under both quantity and price competition, and the incentive for licensing is higher under price competition than under quantity competition. Our qualitative results hold even with decentralized unions.

JEL-Classification: D43; L13; O34

Keywords: Licensing; Labor union; Price competition; Quantity competition

1. Introduction

It is commonly believed that a monopolist final goods producer with proprietary technology has no incentive to share its knowledge with another firm, since competition reduces total profits in the product market.¹ However, empirical evidence shows that firms often create independently managed rival firms supplying similar products and competing in the same market (see Yuan, 1999, for the evidence). The existing theoretical explanations suggest that these two facts can be consistent and a *monopoly final goods producer* may find it profitable to create competition through technology licensing² in the presence of product differentiation, network externality and strategic trade policy. In a closed economy, Wang and Yang (1999), Mukherjee and Balasubramanian (2001), Wang (2002) and Faulí-Oller and Sandonis (2002) suggest that licensing by a monopolist final goods producer is profitable if the products are horizontally differentiated, while Economides (1993) shows network externalities as a reason for licensing by a monopolist producer. Mukherjee and Pennings (2006) show that the presence of strategic trade policy may be a rationale for licensing by a monopolist producer in an open economy.³

In this paper we provide a new rationale for licensing by a monopolist final goods producer in a closed economy. We show that a monopolist final goods producer may prefer to create competition by licensing its technology if the labor market is unionized. While higher competition in the product market tends to reduce profit of

¹ Seade (1980) is an earlier formalization to show that total profits in the product market decrease with more competitors.

² Technology licensing is an important element of conduct in the business world, and the economic literature has considered several strategic motivations for technology licensing in oligopolistic markets. See Rostoker (1984) and Kamien (1992) for surveys on technology licensing. More recently, Anand and Khanna (2000) report that licensing is common in sectors such as chemicals, biotechnology, software, computers, and electrical and non-electrical machinery, accounting for about 20 – 33 percent of all alliances, depending on the sector.

³ There is related literature in which a monopolist input supplier finds it profitable to create competition in the input market through licensing if it either increases competition in the final goods market (Farrell and Gallini, 1988) or it increases quality of the input (Shepard, 1988). Mukherjee and Ray (2007) compare the effects of licensing and R&D on the input supplier and social welfare.

the monopolist producer, it also tends to reduce the wage rate charged by the labor union. We show that a suitably designed licensing contract (i.e. a proper combination of up-front fixed-fee and output royalty) helps to dominate the competition effect by the wage effect, and makes licensing profitable to the monopolist final goods producer. Under centralized union and if the product market (under competition) is characterized by quantity competition, we show that the incentive for licensing is positive under both uniform and discriminatory wage settings. However, the incentive for licensing is higher under the former situation. We also show that the monopolist producer has the incentive for licensing under price competition, and our result suggests that the incentive for licensing is higher under price competition than under quantity competition. Our qualitative results also hold with decentralized unions. Hence, even if there is no network externality and the products are perfect substitutes, a monopolist producer may have the incentive for licensing if licensing provides a strategic advantage in the labor market. It may be worth noting that although we consider labor union as the upstream agent, our analysis is also applicable if the upstream agent is a profit-maximizing firm who is selling an intermediate input to the final goods producer(s) with a linear price.⁴

⁴ Naylor (2002) shows the (industry) profit raising effect of *exogenous* entry. Naylor (2002) considers a firm-specific labor union that sets the wage rate to maximize its own utility, which implies that entry of a firm also increases the number of labor unions. However, in our analysis with an industry-wide (or national) labor union (such as Zhao, 1995 and 1998, and Haucap et al., 2000 and 2001, to name a few), which sets the wage rate to maximize its utility from the industry-wide labor supply, the number of labor union remains the same in our analysis.

Unionization structure differs significantly between countries. While decentralized wage setting may be relevant, e.g., in Japan and North America, centralized wage setting is relevant, e.g. in Germany and Scandinavia (more on this in section 3.1). For cross-country comparison on labor markets, one may refer to Nickell (1997), Blau and Kahn (1999) and Wallerstein (1999). Hence, the present paper and Naylor (2002) may be applicable for different economies. It is also important to note that *exogenous entry* such as in Naylor (2002) does not increase industry profit in our analysis with a centralized union, as shown in the following analysis. *Endogenous entry* in the present paper helps to increase industry profit by manipulating the royalty rate (more on this later) and makes our analysis of entry significantly different from Naylor (2002). Further, unlike him, we conduct our analysis for both price competition and quantity competition, and show the incentive for licensing under different types of product market competition.

Horn and Wolinsky (1988) mention that a firm may have the incentive to operate different plants and in different countries if it is costly to operate a centralized union across geographically

Our results are in line with the empirical analysis of Marginson (1985). Using data on the large UK companies, Marginson (1985) shows that the multidivisional form of corporate organization can be seen as a response to the growing strength of labor unions.

As correctly pointed out in Grandner (2006), although vertical linkages in the production process have significant influence on the economic outcomes, the vertical perspective is seldom the focus of economic analysis. Grandner (2006) shows the effects of the franchising contract between the vertically related firms on the wage bargaining between the final goods producer and labor union. In contrast, in an economy with a unionized labor market, we consider the incentive for licensing to a competitor producing similar products. Thus, the present paper complements Grandner (2006), and may have relevance for technology licensing in countries with strong labor unions, e.g., in the European countries.

Besides the literature on technology licensing, the present paper is also relevant to the literature on divisionalization, where, *in an oligopolistic market*, a final goods producer finds it profitable to create an independent division in the product market. Schwartz and Thompson (1986) and Veendorp (1991) show that entry deterrence may be the rationale for divisionalization. In a two-stage game, Corchon (1991), Polasky (1992), Baye et al. (1996) and Corchon and Gonzales-Maestre (2000) analyze whether divisionalization is an equilibrium phenomenon in the duopoly market with homogeneous products, and Yuan (1999) analyzes this existence problem in an oligopolistic market with differentiated products. However, the main rationale for divisionalization in the above-mentioned papers is its business-staling effect in the product market. *Divisionalization occurs if it provides a strategic advantage in the*

separated plants. Our explanation is clearly different from theirs and does not relate to the cost of union across different plants.

product market, and a monopoly firm has no incentive for divisionalization. In contrast, we show that a monopolist producer creates competition in the product market, since competition in the product market provides a strategic advantage on the labor market.

The remainder of the paper is organized as follows. Section 2 analyzes the case of a monopolist producer without licensing. Section 3 shows the monopolist's incentive for licensing when the product market (under competition) is characterized by quantity competition. We consider uniform and discriminatory wage settings in sections 3.1 and 3.2 respectively. Section 4 shows the incentive for licensing under price competition. Section 5 considers the case of decentralized unions. Section 6 concludes.

2. Monopoly

Let us consider the market for a single product with a monopolist producer, called incumbent. Assume that production requires only labor and, for simplicity, we assume that one labor is used to produce one unit of output, and there is no fixed cost of production. The wage rate for labor is determined by a centralized labor union (as in Zhao, 1995 and 1998, and Haucap et al., 2000 and 2001, to name a few). To show the incentive for licensing by the monopolist producer in the simplest way, we consider a monopolist labor union as in Dunlop (1944) and Oswald (1982). Extending our analysis to incorporate bargaining between the firm(s) and the union will not add new insights to our approach. Like Nickell and Andrews (1983), Haucap et al. (2000 and 2001), Naylor (2002), Lommerud et al. (2003), López and Naylor (2004) and many others, we consider a right-to-manage model of labor union, where the labor union chooses the wage rate to maximize its utility and the firm(s) have right-to-manage

autonomy over employment.⁵ Further, for simplicity, we assume that the reservation wage rate for each labor is zero.

Assume that the inverse market demand function for the final product is

$$P = a - q, \quad (1)$$

where the notations have usual meanings.

We consider the following game. At stage 1, the union sets the wage rate. At stage 2, the incumbent chooses its output and the profits are realized. We solve the game through backward induction.

Given the wage rate w , the optimal output of the incumbent and hence, the demand for labor is

$$q_I = \frac{(a - w)}{2}. \quad (2)$$

We consider the utility of the union as $U = wq$ (see, e.g., Naylor, 2002 and Lommerud et al., 2003).⁶ The union chooses a wage rate to maximize its utility:

$$\text{Max}_w \frac{w(a - w)}{2}. \quad (3)$$

The optimal wage rate is $w^m = \frac{a}{2}$. Hence, total demand for labor and the optimal

profit of the incumbent are respectively $\frac{a}{4}$ and $\pi_i^m = \frac{a^2}{16}$. Utility of the union is

$$U^m = \frac{a^2}{8}.$$

3. Licensing: quantity competition

Let us now examine the incentive for licensing by the incumbent.

⁵ The ‘efficient bargaining’ model, which stipulates that the firms and unions bargain over wages and employment, is an alternative to the right-to-manage model. See, Layard et al. (1991) for arguments in favor of right-to-manage models.

⁶ Note that total labor supply is equal to total output.

3.1. Uniform wage setting

We consider the following game. At stage 1, the incumbent decides whether to license its technology to another firm,⁷ called entrant, which will compete with the incumbent with a homogenous product. Under licensing, we assume that the incumbent gives a take-it-or-leave-it licensing offer with an up-front fixed-fee, F , and per-unit output royalty, r . The licensee either accepts or rejects the licensing offer. The licensee accepts the licensing offer if it is not worse-off under licensing than no licensing.⁸ At stage 2, the union sets the uniform wage rate. At stage 3, the firms choose their outputs simultaneously, if the incumbent licenses at stage 1. If there is no licensing at stage 1, the incumbent operates like a monopolist. We solve the game through backward induction.

It is well-known that an upstream agent will prefer price discrimination over uniform pricing if there are differences in the downstream agents (Yoshida, 2000). Hence, it is arguable that the labor union may prefer to charge different wages to different firms if the royalty rate creates marginal cost difference between the firms. However, empirical evidences suggest that in many situations a labor union charges uniform wage irrespective of the differences between the firms. As discussed in Haucap et al. (2000 and 2001), a common feature of many labor markets in continental Europe is ‘coverage extension rules’, which implies that some or all employment terms are made generally binding for all industry participants and not only for the members of unions and employers’ associations. “In Germany, for example, collective

⁷ In general, one may want to ask how many licenses the monopolist would like to provide in the presence of a labor union. However, to serve the purpose of this paper, viz., to show the incentive for licensing by a monopolist, in the simplest way, we restrict our attention to one licensing contract. More licenses will only strengthen our result.

⁸ For simplicity, we assume away the cost of entry for the licensee and assume that its reservation payoff is zero. It is trivial that positive cost for entry for the licensee will reduce the incentive for licensing.

wage agreements between a union and an employers' association can be made compulsory even for independent employers through so-called *Allgemeinverbindlicherklärung* (AVE) ... The Ministry of Labor can, on application of either unions or employers' associations, use an AVE to make some or all terms of a collectively negotiated employment contract generally binding for an entire industry, where otherwise only those unions, employers and employers' associations that have actually negotiated and signed the contract would be directly bound by it (§3 I TVG)" (Haucap et al., 2001). It is also noted in Haucap et al. (2001) that the number of AVEs almost continuously increased from 448 in 1975 to 588 in 1998.⁹ Thus, it justifies our analysis with uniform wage setting by the labor union.

If there is no licensing, it is trivial that the analysis will be similar to section 2. Now, consider the game under the history of licensing at stage 1.

If there is licensing at stage 1, the equilibrium outputs and profits of the incumbent and the entrant are respectively

$$q_i^* = \frac{(a - w + r)}{3} \quad \text{and} \quad q_e^* = \frac{(a - w - 2r)}{3} \quad (4)$$

$$\pi_i^* = \frac{(a - w + r)^2}{9} + \frac{r(a - w - 2r)}{3} + F \quad \text{and} \quad \pi_e^* = \frac{(a - w - 2r)^2}{9} - F. \quad (5)$$

It is important to note that output of the entrant is zero for $w \geq a - 2r$.

Hence, total demand for labor is

$$q_I = q_i^* + q_e^* = \frac{(2a - 2w - r)}{3}, \quad \text{for } w < a - 2r \quad (6)$$

$$q_I = q_i^* = \frac{(a - w)}{2}, \quad \text{for } w \geq a - 2r. \quad (7)$$

It is clear from (7) that there is no demand for labor if $w > a$.

⁹ Haucap et al. (2001) also show when the labor union may prefer a uniform wage over discriminatory

3.2. The wage rate and the profits

Given the demand for labor under licensing, it should be noted that the labor union might not charge the wage rate in a way that accommodates both of the firms. In other words, the labor union may be better off by charging a wage rate that induces only the incumbent to produce and makes the threat of competition from the license incredible. Before discussing this issue, let us first consider the optimal wage rate when both firms produce on the product market.

If both firms demand labor, the union maximizes the following expression to determine the wage rate:

$$\text{Max}_w \frac{w(2a - 2w - r)}{3}. \quad (8)$$

The optimal wage rate is $w = \frac{2a - r}{4}$. Given the wage rate $w = \frac{2a - r}{4}$, the utility of

the union is $U^{c,d} = \frac{(2a - r)^2}{24}$. It should be noted that, given r and the optimal wage

rate, the entrant produces provided $r < \frac{2a}{7}$.

Therefore, at stage 1, the incumbent maximizes the following expression:

$$\text{Max}_{F,r} \frac{(2a + 5r)^2 + 12r(2a - 7r)}{144} + F \quad (9)$$

$$\text{subject to } \frac{(2a - 7r)^2}{144} - F \geq 0.^{10} \quad (10)$$

Given that the reservation payoff of the licensee is zero and the incumbent has full bargaining power, the maximum fixed-fee fee will be $F = \frac{(2a - 7r)^2}{144}$. With this

maximum fixed-fee, the maximization problem of (9) becomes:

wage.

¹⁰ If condition (10) is not satisfied, the licensee does not accept the licensing contract, since, in that situation, the licensee is better off under no licensing than under licensing.

$$\text{Max}_r \frac{(2a+5r)^2 + (2a-7r)^2 + 12r(2a-7r)}{144}. \quad (11)$$

The maximization of (11) gives the optimal royalty rate as $r = \frac{4a}{5}$. However, due to

$\frac{4a}{5} > \frac{2a}{7}$, the constraint for positive output of the entrant is binding and implies that

the royalty rate does not exceed $\frac{2a}{7}$.

It is important to note that the maximization problem (11) has assumed that the threat of competition in the product market is credible. But, as mentioned already, ex-post licensing, the labor union may charge the wage rate in a way that eliminates the credible threat of competition. In fact, given the royalty rate $\frac{2a}{7}$, if the labor union charges the wage rate $\frac{a}{2}$, which is the optimal wage rate under monopoly, then at stage 3 it is optimal for the incumbent to choose its monopoly output corresponding to the wage rate $\frac{a}{2}$. Thus, if the royalty rate is $\frac{2a}{7}$, it is optimal for the union to charge $\frac{a}{2}$, and the optimal outputs of the incumbent and the entrant are respectively $\frac{a}{4}$ and 0. Hence, this licensing contract does not create a credible threat of competition, and generates market outcomes similar to monopoly of the incumbent.

Therefore, to make the threat of competition credible, the royalty rate must be such that it induces the labor union to charge the wage rate corresponding to the duopoly market structure, i.e., $w = \frac{2a-r}{4}$, rather than the wage rate $\frac{a}{2}$. Therefore, the royalty rate needs to satisfy the incentive constraint for the labor union, i.e.,

$$\frac{(2a-r)^2}{24} \geq \frac{a^2}{8}, \quad (12)$$

which gives the optimal royalty rate as $r^{c,d} = a(2 - \sqrt{3})$, and the corresponding wage rate is $w^{c,d} = \frac{a\sqrt{3}}{4}$. Utility of the union is $U^{c,d} = \frac{a^2}{8}$. The *total* profit of the incumbent is

$$\pi_i^{c,d} = \frac{a^2}{144} \left[(12 - 5\sqrt{3})^2 + (7\sqrt{3} - 12)^2 + 12(2 - \sqrt{3})(7\sqrt{3} - 12) \right]. \quad (13)$$

A comparison of (13) with the incumbent's profit under monopoly gives the following result.

Proposition 1: *If the centralized labor union charges uniform wage rates to the firms, licensing is a profitable strategy for the monopolist incumbent.*

The intuition for this result is easy to understand. Licensing creates competition in the product market, which tends to reduce profit of the incumbent for a given wage rate. However, as the royalty rate increases, it makes the demand function for labor more elastic and reduces the wage rate, thus increasing production efficiency by reducing the marginal cost of production, which has a positive impact on profit. Positive royalty rate also helps to soften competition in the product market. Hence, a properly chosen royalty rate does not increase competition in the product market significantly but helps to reduce the wage rate, thus makes licensing profitable for the monopolist incumbent.

3.3. Wage discrimination

Now, we relax the assumption of uniform wage setting and consider the incentive for licensing under wage discrimination by the labor union.¹¹

¹¹ This wage setting behavior is similar to the centralized bargaining model of Bughin and Vannini (1995) and Vannini and Bughin (2000), and 'coordination' wage setting of Haucap and Wey (2004).

If the union discriminates wages between the firms and charges w_i and w_e to the incumbent and the entrant respectively, the optimal outputs and profits of the incumbent and the entrant are respectively

$$q_i^* = \frac{(a - 2w_i + r + w_e)}{3} \quad \text{and} \quad q_e^* = \frac{(a - 2w_e - 2r + w_i)}{3} \quad (14)$$

$$\pi_i^* = \frac{(a - 2w_i + r + w_e)^2}{9} \quad \text{and} \quad \pi_e^* = \frac{(a - 2w_e - 2r + w_i)^2}{9}. \quad (15)$$

The union chooses w_i and w_e to maximize the following expression:

$$\text{Max}_{w_i, w_e} \frac{w_i(a - 2w_i + r + w_e) + w_e(a - 2w_e - 2r + w_i)}{3}. \quad (16)$$

The optimal wage rates are

$$w_i = \frac{a}{2} \quad \text{and} \quad w_e = \frac{(a - r)}{2}. \quad (17)$$

Since the incumbent has full bargaining power and the reservation payoff of the licensee is zero, therefore, at stage 1, the incumbent chooses r to maximize the following expression:

$$\text{Max}_r \frac{(a + r)^2 + (a - 2r)^2 + 6r(a - 2r)}{36}. \quad (18)$$

The optimal royalty rate is $r^* = \frac{2a}{7}$. Note that the outputs of both firms are positive in this situation. It is worth noting that, since, here the labor union discriminates wage, we do not need to satisfy a constraint similar to (12).

We find that the *total* profit of the incumbent is $\pi_i^{*,d} = \frac{a^2}{14}$, which immediately implies that licensing is a profitable strategy for the incumbent even under wage discrimination. However, under licensing, the total profits of the incumbent under uniform wage and wage discrimination show that the total profit of the incumbent is higher under the former situation. Therefore, the benefit from licensing is higher under

uniform wage setting, and, given a cost of entry for the licensee, it is trivial that licensing may occur only under uniform wage setting.

The following proposition results from the above discussion.

Proposition 2: *If the centralized labor union discriminates wages between the firms, licensing is a profitable strategy for the monopolist incumbent. However, the incentive for licensing is higher under uniform wages than under wage discrimination.*

Even if the wage rate for the incumbent is the same under licensing and no licensing (i.e., monopoly), licensing helps to produce some amount of output in a new firm with a relatively lower wage rate. Since the incumbent can design a suitable licensing contract to soften competition in the product market and to extract profit from the licensee, the benefit from a lower wage rate in the new firm encourages the incumbent to license its technology. Since, under wage discrimination, licensing does not reduce the wage rate for the incumbent, wage discrimination reduces the benefit of licensing compared to the situation of uniform wage setting.

It is easy to check from (18) that if there is no output royalty to soften competition in the product market, the industry profit under licensing is $\frac{a^2}{18}$, which is

lower than that of under monopoly, which is $\frac{a^2}{16}$. Therefore, without output royalty,

licensing is an unprofitable strategy to the incumbent. Note that this situation of no output royalty under licensing is comparable to “*exogenous entry and discriminatory wage setting*” of Naylor (2002) but with a single labor union, and shows that here *exogenous entry* does not increase the industry profit, thus showing the *importance of*

endogenous entry with a two-part tariff (i.e., fixed-fee and output royalty) licensing contract, and making our analysis of entry significantly different from Naylor (2002).

4. Licensing: price competition

This section extends the basic model of section 3.1 in another direction, viz., to consider price competition under licensing, and shows that the incentive for licensing remains even under price competition. To abstract the effect of product differentiation, which makes licensing profitable even with no labor union (e.g., Wang and Yang, 1999), we consider the case of homogeneous product also under price competition.

It is trivial that the case of no licensing is similar to section 2. However, the analysis under price competition is different from quantity competition when there is competition in the product market.

Let us now consider licensing. Given the positive royalty rate, since the effective marginal cost of the entrant is $(w + r)$, it is higher than the incumbent's marginal cost of production, which is w . Thus, the equilibrium price in the product market is $(w + r)$,¹² and only the incumbent produces. The output of the incumbent and therefore the demand for labor is

$$q_I = a - w - r. \quad (19)$$

The union maximizes the following expression to determine the wage rate:

$$\text{Max}_w w(a - w - r). \quad (20)$$

The optimal wage rate is $w = \frac{(a - r)}{2}$. Utility of the labor union and the *total* profit of

the incumbent are respectively $U^{b,d} = \frac{(a - r)^2}{4}$ and $\pi_i^{b,d} = \frac{r(a - r)}{2}$. Therefore, if the

¹² It assumes that, given the wage rate, the monopoly price for the final good is greater than $(w + r)$. This happens if $a - 2r > w$.

incumbent maximizes $\pi_i^{b,d} = \frac{r(a-r)}{2}$ to determine the royalty rate, the optimal

royalty rate is $r = \frac{a}{2}$.

However, note that, given the royalty rate $r = \frac{a}{2}$, the labor union can always charge the wage rate $w = \frac{a}{2}$ to eliminate the credible threat of entry in the product market. Hence, like section 3.1, the incumbent needs to charge the royalty rate in a way so that the labor union charges its optimal wage rate corresponding to the duopoly market structure, i.e., $w = \frac{(a-r)}{2}$. Hence, the optimal royalty rate needs to satisfy the incentive constraint for the labor union, i.e.,

$$\frac{(a-r)^2}{4} \geq \frac{a^2}{8}, \quad (21)$$

which gives the optimal royalty rate as $r^{b,d} = \frac{a(\sqrt{2}-1)}{\sqrt{2}}$, and the corresponding wage

rate is $w^{b,d} = \frac{a}{2\sqrt{2}}$.

Therefore, the *total* profit of the incumbent is

$$\pi_i^{b,d} = \frac{a^2(\sqrt{2}-1)}{4}, \quad (22)$$

which is greater than the incumbent's profit under monopoly, thus making licensing a profitable strategy for the monopolist.

Comparison of (22) with (13) shows that the former is always greater than the latter, which implies higher profit of the incumbent in a product market with more intense competition. Therefore, it is immediate that, given a cost of entry for the licensee, it may be possible that licensing occurs only under price competition.

Recently, López and Naylor (2004) show that if there are firm-specific labor unions, price competition generates higher profit provided either the bargaining power of the labor union or the importance of wage in the utility of the labor union is very high. In contrast, we show that, if there is an industry-wide labor union, price competition can generate higher profits compared to quantity competition even if the wage rate and employment get the same weight in the utility function of the union.¹³

The following proposition is immediate from the above discussion.

Proposition 3: *If there is a centralized labor union, licensing by a monopolist producer can be profitable under price competition. Further, for the comparable situations, the incentive for licensing can be higher under price competition than under quantity competition.*

The reason for profitable licensing under price competition is also attributable to the beneficial wage effect of licensing. The intuition for higher profit under price competition compared to quantity competition is as follows. In case of price competition, only the incumbent produces the final goods. Furthermore, the wage rate is lower under price competition than under quantity competition. Thus, while lower a wage rate and higher market share tend to increase profit of the incumbent under price competition, the lower price of the product tends to reduce its profit under price competition. However, a suitable licensing contract helps the incumbent to soften competition in the product market, thus reducing the negative product price effect. In balance, the beneficial wage rate and market share effects dominate the harmful

¹³ In different contexts, Acharyya and Marjit (1998), Häckner (2000), Mukherjee (2005) and Zanchettin (2005) show higher profit of a firm under price competition than under quantity competition in absence of labor union.

product price effect, and create higher profit under price competition compared to quantity competition.

5. Decentralized unions

So far we have focused on a centralized union. Let us now see the implications of decentralized unions on our analysis. Under decentralized unions, there are firm-specific unions and the unions choose the respective wage rates to maximize their objective functions.

In this section, we consider a game structure similar to the one mentioned in section 2. Hence, at stage 1, the incumbent firm decides whether to license or not. At stage 2, the wage rate is determined by decentralized labor unions. At stage 3, the firms take their output or price decisions simultaneously and the profits are realized.

Note that the analysis under monopoly will not be affected even in case of decentralized unions, since there is only one producer in the economy. However, the above analysis will be affected by decentralized unions, since now each firm will face a separate labor union.

5.1. Quantity competition

Under licensing, if the firms compete like Cournot duopolists, then given the licensing contract, the equilibrium outputs and profits of the incumbent and the entrant are respectively:

$$q_i^* = \frac{(a - 2w_i + w_e + r)}{3} \quad \text{and} \quad q_e^* = \frac{(a - 2w_e - 2r + w_i)}{3} \quad (23)$$

$$\pi_i^* = \frac{(a - 2w_i + w_e + r)^2}{9} \quad \text{and} \quad \pi_e^* = \frac{(a - 2w_e - 2r + w_i)^2}{9}, \quad (24)$$

where w_i and w_e are the wage rates faced by the incumbent and the entrant respectively.

Therefore, the unions specific to the incumbent and the entrant choose the wage rates w_i and w_e to maximize the following expressions:

$$\text{Max}_{w_i} w_i \frac{(a - 2w_i + w_e + r)}{3} \quad (25)$$

$$\text{Max}_{w_e} w_e \frac{(a - 2w_e - 2r + w_i)}{3}. \quad (26)$$

The equilibrium wage rates are $w_i = \frac{(5a + 2r)}{15}$ and $w_e = \frac{(5a - 7r)}{15}$.

Therefore, the incumbent maximizes the following expression to determine the royalty rate:

$$\text{Max}_r \frac{(10a + 4r)^2}{2025} + \frac{45r(10a - 14r)}{2025} + \frac{(10a - 14r)^2}{2025}. \quad (27)$$

The equilibrium royalty rate is $r = \frac{125a}{418}$. It follows from (23) and the equilibrium

wage rates that the entrant produces positive amount provided $r < \frac{10a}{14}$. Since the

equilibrium royalty rate, $r = \frac{125a}{418}$, is lower than the royalty rate that is necessary to

ensure positive output by the entrant, it is evident that the incumbent finds it profitable to license its technology to the entrant. Therefore, our basic conclusion about creating competition by a monopolist producer in presence of labor union remains.

3.2. Price competition

Let us now consider the case where, under licensing, the firms compete like Bertrand duopolists.

Given the wage rates, if $w_i > w_e + r$, the output of the incumbent is zero and the utility of the labor union related to the incumbent is also zero. In this situation only the entrant produces.

If $w_i < w_e + r$, the incumbent has two options: It can charge a price equal to (strictly speaking slightly lower than) $w_e + r$, and get the full market. In this situation, the profit of the incumbent is $(w_e + r - w_i)(a - w_e - r)$. Or, it can charge a price slightly higher than $w_e + r$. In this situation, only the entrant will produce at a price $w_e + r$, and the profit of the incumbent will be $r(a - w_e - r)$. Note that since the fixed-fee is sunk at the price setting stage, it does not affect the calculations at this stage. The incumbent prefers the first option, i.e., where only the incumbent produces at a price $w_e + r$, and demands labor provided

$$w_i \leq w_e. \quad ^{14} \tag{28}$$

However, if (28) is not satisfied, only the entrant produces and demands labor.

Knowing that the labor demand by the incumbent firm would be zero if $w_i > w_e$, it is evident that, given w_e , the wage rate charged by the union specific to the incumbent does not exceed w_e . On the other hand, given w_i , the union specific to the entrant also has the incentive to undercut w_i for getting positive labor demand. This wage undercutting continues until both w_i and w_e the wage rates reach the reservation wage rate zero. Otherwise, one of these unions has the incentive to undercut the wage rate of the competing labor union. Hence, in equilibrium, both w_i and w_e equal to zero, and only the incumbent produces a positive amount, which generates the labor demand equal to $(a - r)$ for the union specific to the incumbent.

¹⁴ As a tie breaking rule, we assume that if the incumbent cannot gain by charging a price that induces only the entrant to produce, it charges a price that induces only the incumbent to produce.

Hence, at stage 1, the incumbent chooses the royalty rate to maximize the following expression:

$$\text{Max}_r r(a - r), \quad (28)$$

since the equilibrium wage rates and the output of the entrant are 0. The optimal royalty rate is $r = \frac{a}{2}$, and the profit of the incumbent is $\frac{a^2}{4}$, which is greater than its profit without licensing. Therefore, by creating a potential competitor, the incumbent can reduce the wage rate charged by its labor union, since the potential competition creates the threat of eliminating labor demand faced by the union specific to the incumbent. This strategic effect of competition on the wage rate makes the incumbent better off compared to no licensing.

Therefore, our qualitative result about the incentive for licensing by a monopolist producer under price competition remains even under decentralized unions. Further, since the profit of the incumbent under price competition is $\frac{a^2}{4}$, which is the monopoly profit of the incumbent while facing the marginal cost of production 0, it is immediate that, like centralized union, the incentive for licensing under decentralized unions are higher under price competition than under quantity competition.

6. Conclusion

Empirical evidences show that a firm often creates independent divisions that produce similar products and compete in the same market. Previous theoretical explanations suggest that a monopolist producer may find it profitable to create competition through technology licensing in the presence of product differentiation, network externalities and strategic trade policy.

We provide a new rationale for licensing. We show that licensing can be a profitable strategy for a monopolist producer if the input market is imperfectly competitive. Considering a unionized labor market, we show the profitability of technology licensing by a monopolist producer under quality and price competition and under different types of wage setting behavior of the labor union. In contrast to the product market advantage, we show that licensing is profitable if it gives the monopolist strategic advantage in the labor market. While licensing helps to reduce the wage rate, it also increases competition in the product market. However, a suitably designed licensing contract helps the monopolist to soften product market competition and to reduce the wage rate, thus makes licensing profitable.

Under centralized union, we show that licensing by the monopolist can be profitable under both uniform and discriminatory wage settings by the labor union. However, since the benefit from the lower wage rate is higher under uniform wage rates, the incentive for licensing is higher under uniform wage rates than under wage discrimination. We also show that the incentive for licensing is higher under price competition than under quantity competition. Our qualitative results hold even with decentralized labor unions.

In our paper, we have considered licensing by a monopolist in a homogeneous goods market. If the products are differentiated and/or there are other competitors in the product market, the wage pressing effect of licensing would be reduced, and would reduce the incentive for licensing due to this effect. However, it follows from the existing studies that product differentiation (e.g., Mukherjee and Balasubramanian, 2001) and/or more competitors (Marjit et al., 2000) create the incentive for technology licensing even in the absence of labor union. Thus, with product differentiation and/or more competitors, even if the reason for licensing due to the wage pressing effect may

be reduced, it will be countered by the effects of product differentiation and/or the business stealing effects under more competitors.

It is also important to note that we have assumed that all the firms can get workers only from the labor unions and there is no possibility of substitution between different types of inputs. However, it would be interesting to see the impact if there are workers outside the labor union and/or the firms can substitute between different types of inputs. We leave this issue and the related issues for future research.

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