Patent Licensing and Double Marginalization in Vertically Related Markets with a Nash Bargaining Agreement

Hong-Ren Din
Department of Industrial Economics
Tamkang University

and

Kuo-Feng Kao
Department of Industrial Economics
Tamkang University

and

Wen-Jung Liang*
Department of Economics
National Dong Hwa University
and
Public Economics Research Center
National Taiwan University

Current Version: October 31, 2011

JEL Classification: D43, D45, L13
Keywords: Vertically Related Markets; Nash Bargaining Agreement; Outsider Patentee; Fixed-Fee Licensing; Royalty Licensing.

---

* Corresponding Author: Wen-Jung Liang, Department of Economics, National Dong Hwa University, Shoufeng, Hualien 97401, Taiwan, ROC. Tel: +886-3-8635532, Fax: +886-3-8635530, E-mail: wjliang@mail.ndhu.edu.tw.

Abstract

This paper develops a three-stage model, in which the input price is determined by a Nash bargaining agreement between the upstream and the downstream firms in vertically related markets. The focus of this paper is on the role of the bargaining power of the upstream firm in the choice of the optimal licensing contract and the social welfare, when the outsider patentee licenses out its technology. It shows that the outsider patentee prefers royalty (fixed-fee) licensing to fixed-fee (royalty) licensing, as the bargaining power of the upstream firm is small (large) irrespective of the innovation size. Moreover, it also proves that the social welfare may get improved by switching from a royalty licensing to a fixed-fee licensing selected by the outsider patentee, as the bargaining power of the upstream firm is large enough. This result emerges even though the degree of double marginalization gets worse.

1. Introduction

This paper aims at exploring the following two issues by taking into account vertically related markets with an outsider patentee, where the cost-reducing technology is licensed to the upstream firm and the input price is determined by a Nash bargaining agreement. Firstly, what is the outsider patentee's optimal licensing contract in terms of fixed-fee and royalty licensing? Secondly, does a larger degree of double marginalization existed in the vertically related markets always worsen the social welfare?

There is huge literature discussing the optimal licensing contract, where the innovation is licensed to the final product producers. For example, Kamien and Tauman (1986), Kamien *et al*. (1992), Muto (1993), Poddar and Sinha (2004), and Kabiraj (2004) are literature for outsider patentee; and Wang（1998）, Faulí-Oller and Sandonís (2002, 2003), Kabiraj and Marjit (2003), Poddar and Sinha (2004), Arya and Mittendorf (2006), Mukherjee and Pennings (2006), Poddar and Sinha (2010), and Sinha (2010) are literature for insider patentee. However, we do not find any literature examining the optimal licensing contract, where the innovation is licensed to the upstream producers. To the best of our knowledge, this is the first paper to touch this issue. Licensing technology to the upstream producers is commonplace in the real world. For example, Qualcomm Inc. licensed the CDMA and WCDMA patents to

MediaTek Inc. in November 20, 2009[1]. In this example, Qualcomm owning advanced wireless technologies, while MediaTek is an upstream firm in cell phone market, providing chips for the downstream firms.

It is important in the literature on patent licensing to explore by what means a patent holder would like to license its patent. Empirical studies show that three types of licensing contract prevail in practice: the fixed fee, royalty, and royalty plus fixed fee.[2] The results derived in early theoretical works, such as Kamien and Tauman, (1986) and Kamien *et al*. (1992), indicate that as the patent holder stands outside the industry, a fixed-fee licensing arrangement is generally preferable to royalty licensing when firms choose output rather than price to maximize their profits.

We assume in this paper that the input price is determined by a Nash bargaining agreement between the upstream and downstream firms. This kind of setting is a more general setting in determining the input price. As the upstream firm's bargaining power gets to be weaker (stronger), the input price moves closer to the marginal cost (monopoly price). Furthermore, by using a Nash bargaining agreement, one can connect the degree of double marginalization existed in the vertically related markets with the upstream firm's bargaining power. As the upstream firm's bargaining power

[1] Please refer to the following website: http://news.softpedia.com/news/Qualcomm-and-MediaTek-Announce-Patent-Agreement-127494.shtml

[2] See Rostoker (1984).

gets to be weaker (stronger), the degree of double marginalization becomes smaller (larger). This enables us to examine the impact of technology licensing on the social welfare by changing the degree of double marginalization in various magnitudes of the upstream firm's bargaining power.

The main contribution of this paper can be stated as follows. As the magnitude of the upstream firm's bargaining power is large, the upstream firm has the ability to extract larger profit than the downstream firm. This will attract the outsider patentee to choose a fixed-fee licensing for enhancing the upstream firm's competition power by reducing its marginal production cost. On the contrary, as the magnitude of the upstream firm's bargaining power is small, the downstream firm has the ability to extract larger profit than the upstream firm so that the output of the final product is bigger. Thus, the outsider patentee will choose a royalty licensing due to higher royalty revenue. Next, since the outsider patentee prefers royalty licensing as the upstream firm's bargaining power is small, whereas prefers fixed-fee licensing, otherwise. A fixed-fee licensing can improve social welfare by enhancing the firms' production efficiency via decreasing their production costs. Usually, a larger bargaining power of the upstream firm denotes a larger degree of double marginalization, which will worsen social welfare. However, this paper derives a counter result caused from switching from a royalty licensing to a fixed-fee licensing selected by the outsider patentee.

The remainder of this paper is organized as follows. We show the equilibrium under technology licensing by means of fixed-fee and by means of royalty respectively in Section 2. Section 3 and Section 4 investigate the optimal contract and the welfare effect of technology licensing, respectively. Section 5 concludes this paper.

2. Model Setup

Consider a framework consisting of one outsider patentee, one upstream firm, firm 1, and one downstream firm, firm 2. Assume that one unit final product employs one unit input, and the input price, w, is determined through a Nash bargaining agreement between the upstream and downstream firms. Assume further that the upstream firm's marginal cost is a constant c, while the marginal cost of the downstream firm is the cost of employing the input, i.e., w. The outsider patentee owns an innovation, which can reduce the marginal cost of the upstream firm by the amount ε, where $0 < \varepsilon \leq c$, and licenses its innovation to the upstream firm with either a fixed-fee or a pure royalty licensing contract. Suppose that the inverse demand function for the final product exhibits a linear form $p = a - q_2$, where a is the constant reservation price, q_2 is the quantity demand for the final product and p is the market price.

2.1. The General Model

Consider a general model where the superscript of each variable, i = {N, F, R}, denotes the cases where the technology licensing is absent, licensing by means of fixed-fee contract and licensing by means of royalty contract, respectively. The game in question is a three-stage game. In the first stage, the outsider patentee selects an optimal contract and the optimal fee under the fee licensing or the optimal royalty rate under the royalty licensing. In the second stage, the input price is determined through a Nash bargaining agreement between the upstream firm and the downstream firm. In the final stage, given the type of contract and the input price, the downstream firm determines the output of the final product. The game is solved by backward induction beginning with the final stage.

In the final stage, the downstream firm's profit function is defined as:

$$\pi_2^i = (p - w^i)q_2{}^i \,, \tag{1}$$

where the superscript i = {N, F, R}.

Differentiating π_2^i with respective to q_2^i and letting it equal zero, we can solve for firm 2's equilibrium output as follows:

$$q_2^i = \frac{(a - w^i)}{2} \,. \tag{2}$$

Substituting (2) into (1), the downstream firm's profit function can be rewritten as:

$$\pi_2^i = \frac{(a-w^i)^2}{4}. \tag{3}$$

Next, the upstream firm's profit function is defined as $\pi_1^i = (w^i - c^i)q_1^i$, where q_1^i is the upstream firm's output. Since we assume one unit final product employs one unit input, the upstream firm's equilibrium output will be identical to that of the downstream firm, i.e., $q_1^i = q_2^i$. Thus, the upstream firm's profit function can be rewrite as follows:

$$\pi_1^i = \frac{(w^i - c^i)(a-w^i)}{2}. \tag{4}$$

In the second stage, the upstream firm and downstream firm determine the input price through a Nash bargaining agreement. The Nash bargaining model is a simultaneous bargaining setting, where the threat points of the two firms are set equal to zero. Thus, by using (3) and (4), the input price is determined by the following expression:

$$\max_{w^i} \Omega^i \equiv (\pi_1^i)^{\beta}(\pi_2^i)^{(1-\beta)} = \left[\frac{(w^i - c^i)(a-w^i)}{2}\right]^{\beta}\left[\left(\frac{a-w^i}{2}\right)^2\right]^{(1-\beta)}, \tag{5}$$

where $\beta \in [0,1]$ represents the upstream firm's bargaining power.

Differentiating (5) with respect to w^i, we have the first-order condition as follows:

$$\frac{\partial \Omega^i}{\partial w^i} = \frac{(a-w^i)^{1-\beta}}{2^{2-\beta}(w^i - c^i)^{1-\beta}}\left[\beta(a-c^i) + 2c^i - 2w^i\right] = 0. \tag{6}$$

Solving (6) gives the equilibrium input price:

$$w^i = \frac{[\beta(a-c^i)+2c^i]}{2}. \quad (7)$$

Equation (7) demonstrates that the input price is positively correlated with the upstream firm's bargaining power. The upstream firm charges a monopoly (competitive) price as β equals unity (nil), revealing that the degree of double marginalization increases as β is bigger.

Substituting (7) into (2), we obtain the equilibrium output as follows:

$$q_1^i = q_2^i = (2-\beta)(a-c^i)/4. \quad (8)$$

Next, by substituting (7) into (3) and (4), we can derive the reduced profit functions for the upstream and downstream firm as follows:

$$\pi_1^i = \beta(2-\beta)(a-c^i)^2/8, \text{ and } \pi_2^i = [(2-\beta)(a-c^i)]^2/16. \quad (9)$$

For the case where technology licensing is absent, by substituting $c^N = c$ into (9), we have:

$$\pi_1^N = \beta(2-\beta)(a-c)^2/8, \text{ and } \pi_2^N = [(2-\beta)(a-c)]^2/16. \quad (10)$$

2.2. Fixed-fee Licensing

We are now in a position to explore the optimal fixed-fee in the case where the outsider patentee licenses a cost-reducing technology to the upstream firm by means of a fixed-fee contract in the first stage. Following related literature, assume that the outsider patentee can wrest the entire benefits that the licensee can get by taking the license via charging a fixed-fee. Thus, the optimal fixed-fee can be defined as the profit difference for the licensee between taking and rejecting the license, i.e., $\pi_1^F - F = \pi_1^N$. By substituting the marginal cost in the case of fixed-fee licensing, $c^F = c - \varepsilon$, into (8) and (9), the output and the profit for upstream firm and downstream firm can be derived as:

$$q_1^F = q_2^F = (2-\beta)(a-c+\varepsilon)/4, \tag{11}$$

$$\pi_1^F - F = \beta(2-\beta)(a-c+\varepsilon)^2/8 - F \text{, and } \pi_2^F = [(2-\beta)(a-c+\varepsilon)]^2/16. \tag{12}$$

The optimal fixed-fee, i.e., the outsider patentee's profit, can be derived by taking into account (10)) and (12) as follows:

$$F = \pi_1^F - \pi_1^N = \beta(2-\beta)[(a-c+\varepsilon)^2 - (a-c)^2]/8 > 0. \tag{13}$$

Equation (13) shows that a rise in the upstream firm's bargaining power increases the optimal fixed-fee. This result emerges because the outsider patentee can wrest the whole extra benefits caused from licensing the technology to the upstream firm and the larger the bargaining power of the upstream firm, the higher will be the upstream firm's profit. Thus, we can establish the following lemma.

Lemma 1. *Suppose that the outsider patentee licenses its technology to the upstream firm and the input price is determined by a Nash bargaining agreement. A rise in the upstream firm's bargaining power increases the optimal fixed-fee.*

2.3. Royalty Licensing

We turn to examine the optimal royalty rate in the case where the outsider patentee licenses its technology by means of royalty licensing. By substituting the marginal cost in the case of royalty licensing, $c^R = c - \varepsilon + r$, into (8) and (9), we can derive the equilibrium output and the equilibrium profit for the upstream firm and downstream firm as follows:

$$q_1^R = q_2^R = (2-\beta)(a-c+\varepsilon-r)/4, \tag{14}$$

$$\pi_1^R = \beta(2-\beta)(a-c+\varepsilon-r)^2/8, \text{ and } \pi_2^R = [(2-\beta)(a-c+\varepsilon-r)]^2/16. \tag{15}$$

In the first stage, the outsider patentee determines the optimal royalty rate to maximize its profit. It should be noted that the optimal royalty rate must be no greater than the innovation size, ie., $0 \le r \le \varepsilon$ to ensure that the upstream firm will take the licensing. Thus, the outsider patentee's problem can be described as follows:

$$\max_r R = rq_1^R = \frac{r[(2-\beta)(a-c+\varepsilon-r)]}{4} \text{ subject to } 0 \le r \le \varepsilon. \tag{16}$$

Differentiating (16) with respect to r, we obtain:

$$\frac{\partial R}{\partial r} = \frac{(2-\beta)(a-c+\varepsilon-2r)}{4} \ge 0. \tag{17}$$

Solving (17), we have the optimal royalty rate as follows:

$$r = \begin{cases} \varepsilon & , \, if\ \varepsilon \le a-c, \\ (a-c+\varepsilon)/2, & if\ \varepsilon > a-c. \end{cases} \tag{18}$$

Substituting (18) into (14) and (15), we derive the equilibrium output and the profit for upstream firm and downstream firm under royalty licensing as follows:

$$q_1^R = q_2^R = \begin{cases} (2-\beta)(a-c)/4 & if \quad \varepsilon \le a-c, \\ (2-\beta)(a-c+\varepsilon)/8 & if \quad \varepsilon > a-c. \end{cases} \tag{19}$$

$$\pi_1^R = \begin{cases} \beta(2-\beta)(a-c)^2/8 & if \quad \varepsilon \le a-c, \\ \beta(2-\beta)(a-c+\varepsilon)^2/32 & if \quad \varepsilon > a-c. \end{cases} \tag{20}$$

$$\pi_2^R = \begin{cases} (2-\beta)^2(a-c)^2/16 & if \quad \varepsilon \le a-c, \\ (2-\beta)^2(a-c+\varepsilon)^2/64 & if \quad \varepsilon > a-c. \end{cases} \tag{21}$$

Next, substituting (18) into (16) gives the outsider patentee’s profit under royalty licensing:

$$R = \begin{cases} \varepsilon(a-c)(2-\beta)/4, & if \quad \varepsilon \le a-c, \\ (a-c+\varepsilon)^2(2-\beta)/16, & if \quad \varepsilon > a-c. \end{cases} \tag{22}$$

We find from (21) that a rise in the upstream firm’s bargaining power decreases the outsider patentee’s profit under royalty licensing. The intuition is as follows. Since the outsider patentee’s profit under royalty licensing equals the royalty revenue and one unit of final product employs one unit of input, the royalty revenue is increasing with the output of the final product. Moreover, the downstream firm’s profit and output will be lower, as the bargaining power of the upstream firm is larger. Thus, we have:

Lemma 2. *Suppose that the outsider patentee licenses its technology to the upstream firm and the input price is determined by a Nash bargaining agreement. A rise in the upstream firm’s bargaining power decreases the outsider patentee’s profit under royalty licensing.*

3. The Optimal Licensing Contract

We proceed to examine the optimal licensing contract. This can be done by deducting (13) from (22). Note the outsider patentee's profit under royalty licensing can be changed depending upon the magnitude of the innovation size. In what follows, we discuss these two cases, respectively.

For the case where the innovation size is small, say, $\varepsilon \le a - c$ **:**

In this case, the royalty rate equals the innovation size. Deducting (13) from (22) gives:

$$R - F \ge (<) 0 \qquad iff \qquad \beta \le (>) \frac{2(a-c)}{2a - 2c + \varepsilon} \equiv \hat{\beta}_A . \tag{23}$$

Equation (22) shows that the outsider patentee prefers fixed-fee (royalty) licensing if and only if the upstream firm's bargaining power is large (small), say, larger (smaller) than $\hat{\beta}_A$. Recall Lemmas 1 and 2 that the outsider patentee's profit under royalty (fixed-fee) licensing is decreasing (increasing) in the magnitude of the upstream firm's bargaining power. The intuition behind this result can be stated as follows. As the magnitude of the upstream firm's bargaining power becomes larger, the upstream firm has the ability to extract larger profit from the downstream firm. This will make the outsider patentee choose a fixed-fee licensing to enhance the upstream firm's competition power by reducing its marginal production cost. It follows that the outsider patentee can earn larger profit by wrest the entire extra benefits of the upstream firm from taking the license. On the contrary, as the magnitude of the upstream firm's bargaining power becomes smaller, the ability that upstream firm can extract profit from the downstream firm gets lower such that the input price is lower and the output of the final product is bigger. Thus, the outsider patentee will choose a royalty licensing due to higher royalty revenue.

For the case where the innovation size is large, say, $\varepsilon > a - c$:

In this case, the royalty rate is lower than the innovation size. Deducting (13) from (22) we obtain:

$$R - F \geq (<) 0, \quad iff \quad \beta \leq (>) \frac{(a-c)^2 + \varepsilon(2a - 2c + \varepsilon)}{2\varepsilon(2a - 2c + \varepsilon)} \equiv \hat{\beta}_B, \tag{24}$$

We find from (24) shows that the outsider patentee prefers fixed-fee (royalty) licensing if and only if the upstream firm's bargaining power is large (small), say, larger (smaller) than $\hat{\beta}_B$. The same intuition as that of (23) carries over to this case.

Equations (23) and (24) shows that regardless of the innovation size, the outsider patentee prefers fixed-fee (royalty) licensing if and only if the upstream firm's bargaining power is large (small). Thus, we can establish:

Proposition 1. *Suppose that the outsider patentee licenses its technology to the upstream firm and the input price is determined by a Nash bargaining agreement. The* *outsider patentee prefers fixed-fee* (*royalty*) *licensing if and only if the upstream firm*'*s bargaining power is large* (*small*) *regardless of the innovation size*.

Proposition 1 is in sharp different from those derived in the literature where the outsider patentee always prefers the fixed-fee licensing to the royalty licensing when there is only one final good market. The difference arises from the existence of double marginalization in vertically related markets, whereas there is only one distortion in the one final good market. This difference leads to the result in this paper that the outsider patentee chooses royalty licensing (fixed-fee licensing) as the degree of double marginalization is small (large).

4. Social Welfare and Bargaining Power

The impact of patent licensing on social welfare is another important issue in the related literature. The social welfare is measured as the sum of consumer surplus, $(q_1^i)^2/2$, and firms' aggregate profits including the profits for the downstream firm, the upstream firm and the outsider patentee.

We can calculate the social welfare under fixed-fee licensing by considering (11), (12), and (13) as follows:

$$SW^F = (2-\beta)(6+\beta)(a-c+\varepsilon)^2/32. \tag{25}$$

Similarly, the social welfare under royalty licensing can be derived by taking into account (19), (20), (21), and (22) as follows:

$$SW^R = \begin{cases} (2-\beta)(a-c)[(6+\beta)(a-c)+8\varepsilon]/32 & if \quad \varepsilon \le a-c \\ (2-\beta)(14+\beta)(a-c+\varepsilon)^2/128 & if \quad \varepsilon > a-c \end{cases}. \tag{26}$$

Next, deducting (26) from (25), we obtain:

$$SW^F - SW^R$$
$$= \begin{cases} \varepsilon(2-\beta)[6(a-c)(2-\beta)+\varepsilon(6+\beta)]/32 > 0 & if \quad \varepsilon \le a-c, \\ (a-c+\varepsilon)^2(2-\beta)(10+3\beta)/1128 > 0 & if \quad \varepsilon > a-c. \end{cases} \tag{27}$$

(Insert Figure 1 here)

We use Figure 1 to illustrate the impact of patent licensing on social welfare in the cases of royalty and fixed-fee licensing for small innovation size, say, $\varepsilon \le a-c$. We can calculate from (25) and (26) that the differentials $\partial SW^F/\partial\beta < 0$ and $\partial SW^R/\partial\beta < 0$, demonstrating that the social welfare functions in both cases are decreasing in the upstream firm's bargaining power (β). Since a larger magnitude of β implies a larger degree of double marginalization, it follows that the welfare effect of a rise in the degree of double marginalization is negative. Moreover, the twice differential of the social welfare functions with respect to β are also negative, revealing that these function are concave in β.[3] This means that this welfare effect is increasing in the degree of double marginalization. Next, we find from (27) that the

[3] We calculate from (25) and (26) and obtain:
$\partial SW^F/\partial\beta = -(2+\beta)(a-c+\varepsilon)^2/16 < 0$, $\partial^2 SW^F/\partial\beta^2 = -(a-c+\varepsilon)^2/16 < 0$.
$$\partial SW^R/\partial\beta = \begin{cases} -(a-c)[(a-c)(2+\beta)+4\varepsilon]/16 < 0, & if\ \varepsilon \le a-c \\ -(6+\beta)(a-c+\varepsilon)^2/64 < 0, & if\ \varepsilon > a-c \end{cases}, \quad \partial^2 SW^R/\partial\beta^2 = \begin{cases} -(a-c)^2/16 < 0, & if\ \varepsilon \le a-c \\ -(a-c+\varepsilon)^2/64 < 0, & if\ \varepsilon > a-c \end{cases}.$$

level of the social welfare in the case of fixed-fee licensing is always larger than that in the case of royalty licensing at any value of bargaining power. This result occurs because the upstream firm can produce its product more efficient in the case of fixed-fee licensing than that in the case of royalty licensing caused from lower production cost.

We are now in a position to study the social welfare under the outsider patentee's optimal licensing decision. Recall that the outsider patentee chooses a royalty licensing as the bargaining power of the upstream firm is small, say, $0 \le \beta \le \hat{\beta}_A$, whereas selects a fixed-fee licensing as $\hat{\beta}_A < \beta \le 1$. Figure 1 shows that the social welfare jumps from SW^R up to SW^F as the bargaining power of the upstream firm is larger than the threshold $\hat{\beta}_A$.

In what follows we try to prove that the levels of the social welfare under fixed-fee licensing in the region $\hat{\beta}_A < \beta \le 1$ are higher than that under royalty licensing at $\beta = \hat{\beta}_A$. By substituting $\beta = 1$ into (25) and $\beta = \hat{\beta}_A$ into (26), we can derive:

$$SW^F(\beta = 1) - SW^R(\beta = \hat{\beta}_A) = \frac{\varepsilon(a - c + \varepsilon)^2(12a - 12c + 7\varepsilon)}{32(2a - 2c + \varepsilon)^2} > 0 . \tag{28}$$

Equation (28) indicates that the level of the social welfare under fixed-fee licensing at $\beta = 1$ is higher than that under royalty licensing at $\beta = \hat{\beta}_A$. Since the social welfare functions under fixed-fee licensing is decreasing in the upstream firm's bargaining power, i.e., $\partial SW^F / \partial\beta < 0$, it follows that the levels of the social welfare under fixed-fee licensing in the region $\hat{\beta}_A < \beta \le 1$ are higher than that under royalty licensing at $\beta = \hat{\beta}_A$. Usually, a larger bargaining power of the upstream firm denotes a larger degree of double marginalization, which will worsen social welfare. However, in this paper, we derive a counter result due to switching from a royalty licensing to a fixed-fee licensing selected by the outsider patentee.[4] Thus, we have the following Proposition:

Proposition 2. *Suppose that the outsider patentee licenses its technology to the upstream firm and the input price is determined by a Nash bargaining agreement. The social welfare may get improved as the bargaining power of the upstream firm is large enough. This result emerges even though the degree of double marginalization gets worse.*

5. Concluding Remarks

This paper has developed a three-stage model, in which the input price is determined by a Nash bargaining agreement between the upstream and the downstream firms in vertically related markets. The focus of this paper is on the role of the bargaining

[4] A similar result can be derived in the case where the innovation size is large**, say,** $\varepsilon > a - c$ **.**

$$SW^F(\beta = 1) - SW^R(\beta = \hat{\beta}_B) = (a - c + \varepsilon)^4[(a-c)^2 + 25\varepsilon(2a - 2c + \varepsilon)]/512\varepsilon^2(2a - 2c + \varepsilon)^2 > 0 .$$

power of the upstream firm in the choice of the optimal licensing contract and the social welfare, when the outsider patentee licenses out its technology. Several striking result are derived as follows.

First of all, this paper shows that the outsider patentee prefers royalty (fixed-fee) licensing to fixed-fee (royalty) licensing, as the bargaining power of the upstream firm is small (large) irrespective of the innovation size. Secondly, it proves that the social welfare may get improved by switching from a royalty licensing to a fixed-fee licensing selected by the outsider patentee, as the bargaining power of the upstream firm is large enough. This result emerges even though the degree of double marginalization gets worse.

References

1. Arya, A., and B. Mittendorf, 2006, “Enhancing Vertical Efficiency through Horizontal Licensing,” *Journal of Regulatory Economics* 29, 333-342.
2. Brekke, K.R., and O.R. Straume, 2004, “Bilateral Monopolies and Locational Choice,” *Regional Science and Urban Economics* 34, 275-88.
3. Faulí-Oller, R., and J. Sandonís, 2002, “Welfare Reducing Licensing,” *Games and Economic Behavior* 41, 192-205.
4. Fauli-Oller, R., and J. Sandonis, 2003, “To Merger or to License: Implications for Competition Policy,” *International Journal of Industrial Organization* 21, 655–72.
5. Kabiraj, T., and S. Marjit, 2003, “Protecting Consumers through Protection: The Role of Tariff-induced Technology Transfer,” *European Economic Review* 47, 113-124.
6. Kabiraj, T., 2004, “Patent Licensing in a Leadership Structure,” *The Manchester School* 72, 188-205.
7. Kamien, M., and Y. Tauman, 1986, “Fees versus Royalties and the Private Value of a Patent ,” *Quarterly Journal of Economics* 101, 471-491.
8. Kamien, M.I., S.S. Oren, and Y. Tauman, 1992, “Optimal Licensing of Cost-reducing Innovation,” *Journal of Mathematical Economics*, 21, 483-508.
9. Mukherjee A., and E. Pennings, 2006, “Tariffs, Licensing and Market Structure,” *European Economic Review* 50, 1699-1707.
10. Mukherjee A., 2010, “Competition and Welfare: The Implications of Licensing,” *The Manchester School* 78, 20-40.
11. Muto, S., 1993, “On Licensing Policies in Bertrand Competition,” *Games and*

Economic Behavior, 5, 257-267.

12. Poddar, S., and U.B. Sinha, 2004, "On Patent Licensing in Spatial Competition," *Economic Record*, 80, 208-218.
13. Poddar, S. and U.B. Sinha, 2010, "Patent Licensing from a High-Cost Firm to a Low-Cost Firm," *Economic Record* 86, 384-395.
14. Rostocker, M., 1984, "A Survey of Corporate Licensing," *IDEA*, 24, 59-92.
15. Sinha, U., 2010, "Strategic licensing, exports, FDI, and host country welfare," *Oxford Economic Papers* 62, 114-131.
16. Wang, X. H. (1998), "Fee versus royalty licensing in a Cournot duopoly model", *Economics Letters*, 60, 55-62.

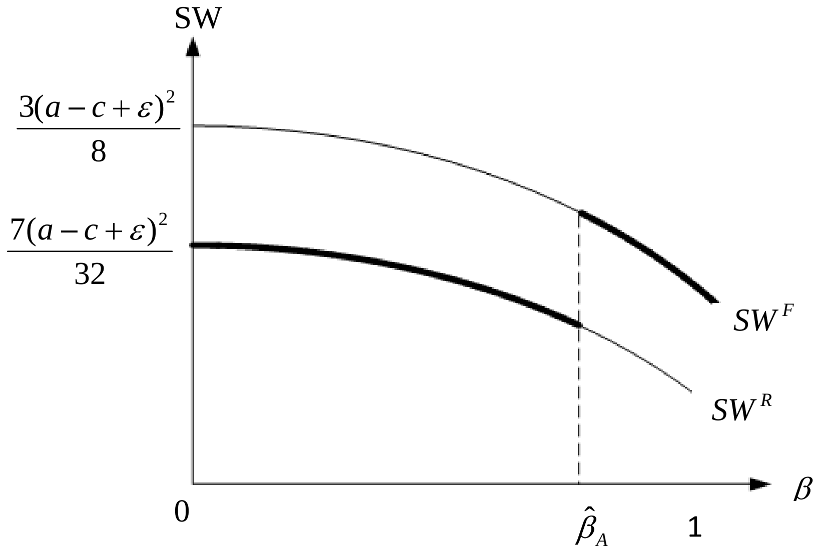

Figure 1. The welfare locus in various licensing contracts for the case of small innovation size.