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A Strategic Effect of Bundling on Product Distribution

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Abstract

Purpose – This study examines a bundling effect on production and distribution in a patent-protected industry. Despite the heavy use of bundling strategies in the information and technology industry, literature has paid scant attention to bundling of intellectual property rights. This study examines a theoretical exploration of the bundling effect on licensing behavior.

Research design, data, and methodology – To address this behavior, we build a simplified model consisting of three stages: 1) bundling decision, 2) licensing agreement, and 3) competition. The subgame perfect Nash equilibrium is applied to the model.

Results – A single-patent holder with superior technology grants its own license to the multiple-patent firm, thereby leaving the market. Anticipating the single right holder's licensing strategy, the multiple-patent firm offers a bundle, making the single-right holder's bargaining position weaker.

Conclusions – Bundling is an effective business strategy, resulting in multiple products for a firm as it faces other firms with single-product lines in each market. Taking advantage of the multi-patent or multi-product lines, the firm utilizes the bundling strategy obtaining better technology from the standalone single-patent firms.

Keywords: Bundling, Patent Licensing, Bargaining, Multi-Market Firms.

JEL Classifications: D21, D45, L11.

1. Introduction

Modern era has seen the intensive protection of intellectual property rights. Critical assets of the information and technology (IT) industry consist in the patents that are indispensable to make the valuable idea materialize by means of legal protection. On the one hand, the leading IT firms hold some major patents that keep away would-be copycat competitors and the markets are monopolized. On the other hand, the guarantee of intellectual property rights for a specified period is thought to promote new invention or innovation. In the long run, the technological progress is construed as the most important factor in order to prolong the fundamental economic growth (Solow, 1956, 1957 Lee, 2014).

In the IT industry, some incumbent firms with established technology own several patents regarding multiple markets. New start-up firms, possibly with better technology, might arise in a particular industry and they challenge the incumbents. For a prominent example, we can take the chipset of cellular phone. Regarding 3G CDMA technology, Qualcomm has a bunch of patents which include many different features encompassing audio and video play. Some other stand alone IT firms need the Qualcomm's patented technology to provide the chipset even if they have better technology singly in either audio or video function. In abstractions, this environment is described where the prevailing firm with multiple patents for many different markets faces standalone competitors in each market. Notably, for the Qualcomm case, the leading firm supplies a bundled chipset licensed to challengers in individual markets.

The business environment we reflect on is not only confined to the information and technology industry, but it rather broadens into the generalized industrial structure such as the firms with distribution channels (Kim & Youn, 2014). The economic system of Korea featured by conglomerates, for instance, is well described by this simplified environment: Some business tycoons own many product lines and control vertically integrated distribution channels while a new start-up firm from a specific market must run a business competing with or against the conglomerates. This kind of industrial structure has evolved through the interactions between economic agents and regulatory regimes. The abstract analysis of this paper might be applied to the industrial ecosystem in which there are a few large business groups competing with small and medium sized standalone firms. Most of large business groups are controlled by founding families and this phenomenon is often observed across the world except for the United States and the United Kingdom (La Porta, Lopez-de-Silanes & Shleifer, 1999).

The main concern is placed on the consequential effect of bundling utilized by the multi-license firm. If the multi-license firm faces a single-license firm with superior technology, does

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the firm with multiple patents have an incentive to bundle those technologies? The problem alludes to antitrust economics since the multi-license firm might leverage its monopolistic power into the market in which it competes with a single-license firm. We need to examine what the bundling strategy brings about and whether the outcome is anti-competitive or not. As noted, the similar results can be obtained when it pertains to the conglomerate dominant economic system. If a business group operating in multiple markets is able to leverage its monopolistic power into another market by bundling, we can take the bundled package from the similar perspective of anti-competitive analysis.

This paper is a theoretical exploration of bundling effect on the patent-protected technology. In regard of the multi-market patents, section 2 reviews the related literature of bundling. Traditional monopoly bundling theory is presented. Main modeling frameworks and results will be accounted in section 3. Constructed is a formal model that addresses the stylizing features of multi- and single-license firms. Based on a simple model, we will prepare the equilibrium outcome in section 4. Lastly, section 5 interprets what we achieve from the stripped-down model.

2. Literature Review

A license is a particular transfer type of intellectual rights whereby the title holder authorizes the licensee to use it under agreement. Technological progress, usually protected by patent system, is frequently licensed to another party with better investment resource or management skill. In the United States, the odds of licensing patents are about 18 percent according to Cockburn and Henderson (2003).

Licensing patents entails the antitrust issue since it grants the right holder a monopoly power and the joint ventures, possibly by licensing, might incur a collusive behavior similar to a merger. The upside of the intellectual right protection is the long-run promotion of innovation while its downside is the short-run"deadweight loss" by the protected monopoly. Balancing both countervailing forces, the U.S. court assesses the cases suspected as an anti-competitive licensing, which is the so-called rule of reason (U.S. Department of Justice & Federal Trade Commission, 1995 Gilbert & Sunshine, 1995).Through the mergers by licensing or R&D joint ventures, a branch of literature emphasizes the enhanced cost efficiency: Avoidance of overlapping effort, allotment to the more efficient product line (Gandal & Scotchmer, 1993), hidden information sharing (Bhattacharya, Glazer & Sappington, 1990; Brocas, 2004), spillovers of the knowledge(Katz & Shapiro, 1987; d'Aspremont & Jacquemin, 1988; Kamien, Muller & Zang, 1992; Suzumura, 1992; Aoki & Tauman, 2001) and so forth.

In exchange of granting license, the right holder requests a fee from the licensee. At the time of drawing an agreement, fixed amount of payment might be asked. It might be continuously charged depending on the licensee's revenue or profit, which is conventionally called royalty. Royalty payment is thought to play a risk sharing role. In this paper, we would consider a static certainty model that the distinction between fixed payment and royalties are not required.

Another strand of related literature is bundling as a measure of price discrimination. Bundling is a business strategy whereby a multi-product firm offers a package sale with discounted price. Contrasted to the classical price theory, combinations of the goods are accounted as well as separate components. Pioneering papers rationalizes the use of bundling from the perspective of monopoly theory. The monopolist with multi-products would like to utilize bundling strategy by sorting and price-discriminating customers (Stigler, 1963; Adams & Yellen, 1976 Schmalensee, 1984; McAfee, McMillan & Whinston, 1989; Bakos & Brynjolfsson, 1999). Almost similar results are achieved even if products are complements or substitutes (Lewbel, 1985). Departing from the price discrimination, some monopoly bundling highlights the role of entry deterrence (Whinston, 1990; Nalebuff, 2004).

Here, in this paper, we take account of another strategic effect of bundling where the multi-patent holding firm monopolizing at least a market could get licensed from the single right holder with superior technology. By bundling multiple products protected by those patents ex ante, the multi-technology firm can deliberately make the single right holders attenuate. In the end, it helps the firm get the patent licensed at less cost in the spirit of Nash (1950).

3. Research design, data and methodology

In this paper, we consider a case in which two innovating firms compete as duopoly. One firm with two different technologies competes with the other one with single technology. The multi-technology firm has a monopolistic power in one market but faces price competition in the other market against the single-technology firm. Additionally, the single-technology firm provides superior quality where both firms compete in the same product. All technologies held by the multi-tech are patented and transferable via license contract.

There are two innovating firms, firm 1 and firm 2. Firm 1 has technologies patented for the production of both good A and good B. Firm 2 has also a patented technology for good B. Given technologies, firm 1 has a sole provider of product A while it's competing with firm 2 in the product market B. However, firm 1's quality of output B is lower than that of firm 2.

A consumer's preference for firm 1's production A and B

$$\theta = (\theta_A, \theta_B) \sim \text{Unif}([0,1] \times [0,1])$$

where θ_A and θ_B are independently and uniformly distributed over a unit interval as configured in Nalebuff (2004).

There are four kinds of commodities a consumer buys: A bundle of A and B (A&B), the multi-patent firm's separate components A and B, and the single holder's product of quality B'. B' is firm 2's production of product B with better quality. Suppose that she buys them at prices, $P = (p_{AB}, p_A, p_B; p_{B'})$. The purchase of each commodity is indivisible at most one unit.

Given preference θ, the utility function of a consumer is

$$u(\theta,P)=(\theta_A-p_A)I_A+(\theta_B-p_B)I_B+(\theta_B+\alpha-p_{B'})I_{B'}+(\theta_A+\theta_B-p_{AB})I_{AB}$$

where I_k is an indicator function for the purchase $k\in\{A,B,B',AB\}$ and α is an augmentation of utility from the purchase of B' rather than B.

From now on, suppose both firms' marginal cost of production be zeros. Firms are competing in the fashion of Bertrand model. Budget constraint of consumer is assumed not binding. As long as the net utility of a unit purchase is positive, she will buy it. Otherwise, she will not include the item in her basket of purchase.

The sequence of competition is depicted in the following figure 1. In the beginning, firm 1 decides the mode of production. The bundle of A&B and B could be offered at the prices p_{AB} and p_B, respectively. Or separate production of A and B in the different market can be considered at the prices p_A and p_B.

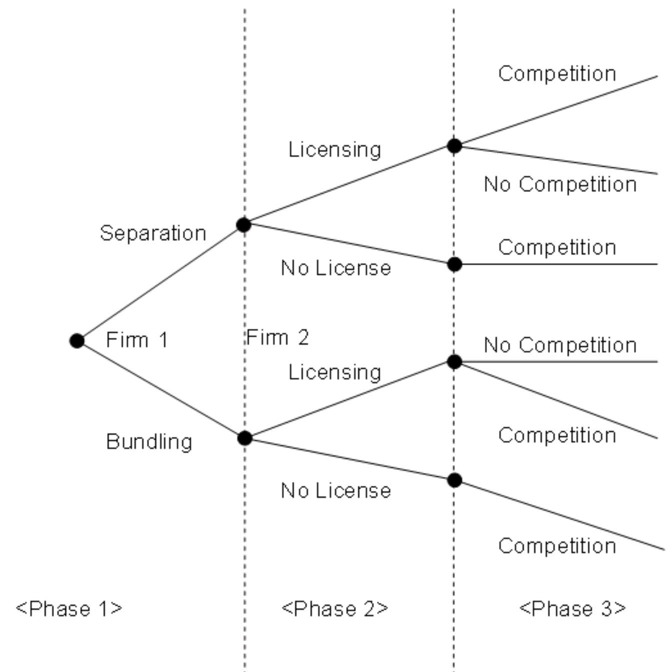
The introduction of bundle is announced in the first phase, which is known to firm 2, the single right holder. Even if firm 1 does not need to commit the promise of bundle, it would be shown that the offer of bundle is credible in the equilibrium as following analyses.

In the second phase, firm 2 observes the firm 1's mode of production. Given that information, firm 2 is able to license its advanced technology to firm 1 or keep it in its own use.

The last phase sees the production with or without competition. If it decides to license the technology of producing good B' with better technology, firm 2 will get some license fee in exchange. Using the license, firm 1 can duplicate B' without any cost so come to equip the same technology as firm 2. Letting two firms at the same foothold, they either compete in the market of product B or only firm 2 stops operating. Both cases of "license with competition" and "license without competition" will be studied.

When they could not come to the license agreement, they will compete in the market B with prices, p_B and $p_{B'}$. It is an asymmetric Bertrand competition since firm 2 provides a product with better quality. This status quo would be a starting position for the bargaining license fee. The break-up of agreement resorts to this "competition without license." Comparing "license with competition" with "competition without license" or "license without competition" with "competition without license," I will study if the agreement of licensing is possible or not.

Drawing upon the backward induction, analysis starts from phase 3 up to phase 1. Here we will show that the simultaneous offer of bundle *A&B* and single product *B* is viable so firm 1 is inducing firm 2 to agree to the license in a better position than it can do when producing *A* and *B* separately.



<Figure 1> Time Line of the Game

4. Results

4.1. Subgame Equilibrium: Separate offering of product A and B in phase 1

4.1.1. No License from firm 2 to firm 1 in phase 2

In market A, firm 1 enjoys a monopolistic profit. The profit function of firm 1 is

$$\pi_A(p_A)=\Pr(\theta_A-p_A\geq 0)p_A=(1-p_A)p_A \tag{1}$$

The first order condition of equation (1) gives $p_A^*=\frac{1}{2}$ and $\pi_A^*=\frac{1}{4}$.

In market B, firm 1 and firm 2 compete in prices. A customer with θ_B such that $\theta_B+\alpha-p_{B'}\geq\theta_B-p_B$ chooses B' in place of B. When a buyer is indifferent between the purchase of B and B' in the light of net utility, we assume she prefer B' with better quality. Suppose that firm 1 charges $p_B=0$. To attract customers, firm 2 offers a price $p_{B'}$ at least as much as α. Setting the price lower than α would reduce the profit while keeping customers exactly as the same as before. Similarly, suppose that firm 2 charges $p_{B'}=\alpha$. Then firm 1 cannot attract additional customers while increasing price above zero. Therefore, $p_B=0$ and $p_{B'}=\alpha$ is a Nash equilibrium. Corresponding profits are $\pi_B^*=0$ and $\pi_{B'}^*=0$.

Lemma 1: When firm 1 produces A and B separately without license, the equilibrium price strategies are

$p_A = \frac{1}{2}$, $p_B = 0$, and $p_{B'} = \alpha$

and firm 1 and firm 2's total profits are

$$\pi^1 \equiv \pi_A^* + \pi_B^* = \frac{1}{4}, \quad \pi^2 \equiv \pi_{B'}^* = \alpha.$$

4.1.2. License with Competition

Similar to the "competition without license," firm 1 is acting as a single monopoly in the market A. So equilibrium strategy and outcome are as follows.

$p_A^* = \frac{1}{2}$ and $\pi_A^* = \frac{1}{4}$.

Now, in market B, firm 2 is equipped with the same technology of firm 1 through licensing. Both firms will compete in ways of symmetric Bertrand model. Therefore, the equilibrium is easily obtained as

$p_B^* = 0$, $p_{B'}^* = 0$ $\pi_B^* = 0$, $\pi_{B'}^* = 0$

when the licensing fee is ignored.

The total profits of firm 1 and firm 2 are

$\pi^1 = \frac{1}{4} - f$ and $\pi^2 = f$,

which are impossible thinking one step back to phase 2 since $\frac{1}{4} - f \geq \frac{1}{4}$ and $f \geq \alpha$ due to lemma 1.

Hence the case of "license with competition" impossible.

4.1.3. License without Competition

Here firm 2 licenses to firm 1 and should not operate in market B aftermath. Now firm 2 is a sole operating firm in both markets.

In market A, there is no technological change so the optimal strategy is

$p_A^* = \frac{1}{2}$ and $\pi_A^* = \frac{1}{4}$.

In market B, firm 1 is to maximize the profit

$$\pi(p_B) = \Pr(\theta_B + \alpha - p_B \geq 0)p_B = \left(1 - (p_B - \alpha)\right)p_B \tag{2}$$

then the first order condition of equation (2) gives the optimal strategy and outcome

$p_B^* = \frac{1+\alpha}{2}$ and $\pi_B^* = \frac{1}{4}(1+\alpha)^2$.

Therefore the total profits of firm 1 and firm 2 are

$\pi^1 = \frac{1}{4} + \frac{1}{4}(1+\alpha)^2 - f$ and $\pi^2 = f$.

Lemma 2: When firm 1 produces A and B with license from firm 2 that is out of market under the agreement, the equilibrium price strategies are

$$p_A = \frac{1}{2}, \quad p_B = \frac{1+\alpha}{2}$$

and firm 1 and firm 2's total profits are

$$\pi^1 = \frac{1}{4} + \frac{(1+\alpha)^2}{4} - f, \quad \pi^2 = f$$

where $\alpha \leq f \leq \frac{(1+\alpha)^2}{4}$.

Since $\frac{(1+\alpha)^2}{4} \geq \alpha$ holds for $\alpha \geq 0$ with the equality only when $\alpha = 1$, we can infer that the "license without competition" is preferred to "competition without license" for both parties. Dividing the surplus of licensing half and half, $\frac{(1-\alpha)^2}{8}$ goes to each firm and firm 1 and firm 2 end up with profits

$\pi^1 = \frac{1}{4}\left[1 + \frac{(1-\alpha)^2}{2}\right]$ and $\pi^2 = \alpha + \frac{1}{8}(1-\alpha)^2$.

In order to check if the "license without competition" under separate productions is better than that under the bundle of A&B as well as a single production of B, we need to turn our analysis to the choice of bundling in phase 2.

4.2. Subgame Equilibrium: Bundling product A and B in phase 1

4.2.1. No License from firm 2 to firm 1:

In market B, firm 1 and firm 2 are competing against each other. But firm 1 could not attract consumers only with inferior product B. So firm 2 always wins competition in the market of single product B setting the price $p_{B'} = \alpha$. If firm 2 sets $p_{B'}$ higher than α then firm 1 has an incentive to undercut the price by small amount to capture whole market B. So firm 2 will end up with zero profit. Contrary to the increase in price, if firm 2 reduces $p_{B'}$ given p_{AB}, it will not increase the market share relating to θ_B but only decrease the profit. It is graphically displayed in the figure 2.

The only remaining concern is on the competition between bundle AB and B'.

For a consumer with $\theta = (\theta_A, \theta_B)$, she will choose a bundle AB if

$$\begin{cases} \theta_A + \theta_B - p_{AB} \geq 0 \\ \theta_A + \theta_B - p_{AB} \geq \theta_B + \alpha - p_{B'} \end{cases} \quad \begin{cases} \theta_A \geq -\theta_B + p_{AB} \\ \theta_A \geq p_{AB} + \alpha - p_{B'} \end{cases}$$

and B' will be chosen by one with θ such that

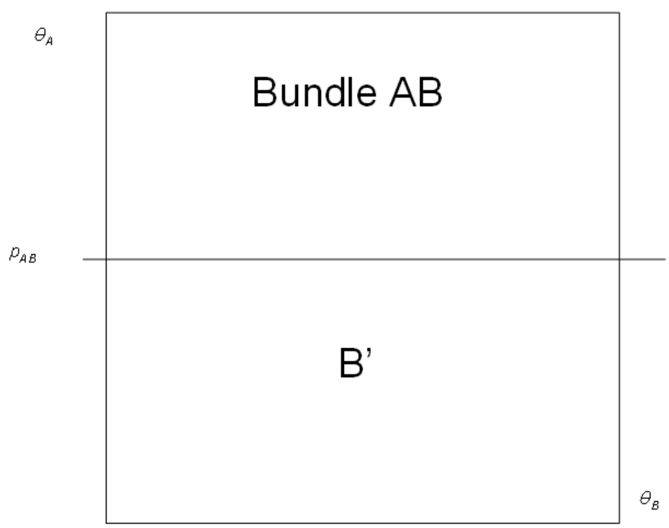
$$\begin{cases} \theta_A + \alpha - p_{B'} \geq 0 \\ \theta_B + \alpha - p_{B'} \geq \theta_A + \theta_B - p_{AB} \end{cases} \quad \begin{cases} \theta_B \geq -\alpha + p_{B'} \\ \alpha - p_{B'} + p_{AB} \geq \theta_A. \end{cases}$$

Imposing $p_{B'} = \alpha$ on inequalities above, bundle AB is chosen by θ satisfying

$$\begin{cases} \theta_A \geq -\theta_B + p_{AB} \\ \theta_A \geq p_{AB} \end{cases} \quad \theta_A \geq p_{AB} \tag{3}$$

$$\begin{cases} \theta_B \geq 0 \\ p_{AB} \geq \theta_A \end{cases} \theta_A \leq p_{AB}. \tag{4}$$

and single product B' is chosen by θ satisfying



<Figure 2> Values without license from firm 2 to firm 1

Firm 2's profit is defined by

$\pi_{AB}(p_{AB}) = (1-p_{AB})p_{AB}$

and the first order condition of the maximization gives

$p^*_{AB} = \frac{1}{2}$ and $\pi^*_{AB} = \frac{1}{4}$.

Firm 1's profit is similarly defined by

$\pi_{B'}(p_{B'}) = p_{AB}p_{B'}$

so $p^*_{B'} = \alpha$ and $\pi^*_{B'} = \frac{\alpha}{2}$.

The total profits of firm 1 and firm 2 are

$\pi^1 = \frac{1}{4}$ and $\pi^2 = \frac{\alpha}{2}$.

Lemma 3: When firm 1 produces bundle AB and B separately without license, the equilibrium price strategies are

$p^*_{AB} = \frac{1}{2}$, $p^*_B = 0$, and $p^*_{B'} = \frac{\alpha}{2}$

and firm 1 and firm 2's total profits are

$\pi^1 \equiv \pi^*_{AB} + \pi^*_B = \frac{1}{4}$ and $\pi^2 \equiv \pi^*_{B'} = \frac{\alpha}{2}$.

4.2.2. License with Competition

In market B, both firms are doing symmetric Bertrand competition. So equilibrium strategies are easily obtained by the same logic of section 4.1.

$p^*_B = p^*_{B'} = 0$ and $\pi^*_B = \pi^*_{B'} = 0$.

We need to consider the competition between bundle AB and B'. Note that, however, the deviation from this equilibrium cannot constitute a Nash equilibrium only considering the competition between B and B'.

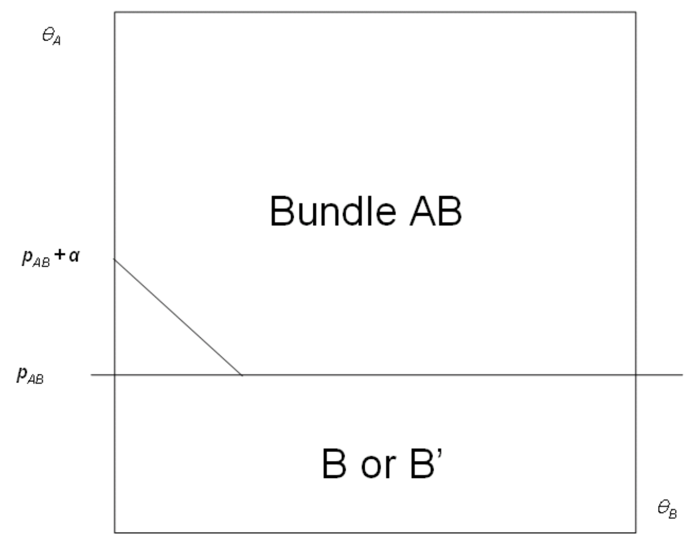
A consumer with θ will choose a bundle AB if

$\begin{cases}\theta_A+\theta_B+\alpha-p_{AB}\ge 0\\ \theta_A+\theta_B+\alpha-p_{AB}\ge\theta_B+\alpha-p_B\end{cases}\begin{cases}\theta_A\ge-\theta_B-\alpha+p_{AB}\\ \theta_A\ge p_{AB}\end{cases}$

and a consumer with θ will choose a single product B' or B if

$\begin{cases}\theta_B+\alpha-p_B\ge 0\\ \theta_A+\theta_B+\alpha-p_{AB}\le\theta_B+\alpha-p_B\end{cases}\begin{cases}\theta_B\ge 0\\ \theta_{AB}\le p_{AB}\end{cases}$

Figure 3 shows the division of types who prefer either a bundle AB or B.



<Figure 3> Values under license with competition

Then the price p_{AB} maximizes the profit of a bundle

$\pi(p_{AB}) = \left[(1-p_{AB}) - \frac{1}{2}\alpha^2\right]p_{AB}$

and the first order condition of maximization problem gives

$p^*_{AB} = \frac{1}{2} - \frac{1}{4}\alpha^2$ and $\pi^*_{AB} = \frac{1}{4}\left(1-\frac{\alpha^2}{2}\right)^2$.

In sum, the profits of firm 1 and firm 2 are

$\pi^1 = \frac{1}{4}\left(1-\frac{\alpha^2}{2}\right)^2 - f$ and $\pi^2 = f$,

which cannot be realized since $\pi^1+\pi^2 = \frac{1}{4}\left(1-\frac{\alpha^2}{2}\right)^2 < \frac{1}{4}+\frac{\alpha}{2}$ when we figure out the possibility of license agreement at phase 2.

Hence the case of "license with competition" impossible.

4.2.3. License without Competition

At this moment, many cases arise. Firm 1 can offer pure bundling, only AB, or bundle AB and single B, or bundle AB, single A, and single B. The best menu of offering depends on the innovation size α. However, the case of bundle AB and a single Bis enough to support the following proposition.

Similarly to the "license with license" when firm 1 offers A and B separately in section 1,

$p^*_A = \frac{1}{2}$ and $\pi^*_A = \frac{1}{4}$

$p^*_B = \frac{1+\alpha}{2}$ and $\pi^*_B = \frac{1}{4}(1+\alpha)^2$.

The total profits of firm 1 and firm 2 are

$\pi^1 = \frac{1}{4} + \frac{1}{4}(1+\alpha)^2 - f$ and $\pi^2 = f$,

respectively.

Lemma 4: When firm 1 produces A and B separately with license from firm 2 that is out of market under the agreement, the equilibrium price strategies are

$p_A = \frac{1}{2}$ and $p_B = \frac{1+\alpha}{2}$

such that firm 1 and firm 2's total profits are

$\pi^1 = \frac{1}{4} + \frac{(1+\alpha)^2}{4} - f$ and $\pi^2 = f$

where $\frac{\alpha}{2} \le f \le \frac{(1+\alpha)^2}{4}$.

Since $\frac{(1+\alpha)^2}{4} > \frac{\alpha}{2}$ holds for $\alpha > 0$, we can infer that the "license without competition" is preferred to "competition without license"for both parties. Dividing the surplus of licensing half and half, $\frac{(1+\alpha^2)}{8}$ splits to each firm and firm 1 and firm 2 end up with profits

$\pi^1 = \frac{1}{4}\left(1 + \frac{1+\alpha^2}{2}\right)$ and $\pi^2 = \frac{\alpha}{2} + \frac{1+\alpha^2}{8}$.

5. Equilibrium and Further Remarks

In section 4.1 and 4.2, we have considered the problem at the second stage. By lemma 1 and lemma 2, firm 2 would prefer to license with a promise of not producing B' once firm 1 decides to produce A and B separately. Due to lemma 3 and lemma 4, we come to know that the single-patent holder of superior quality would also prefer to grant license with a promise of not producing B'. Given this license, firm 1 decides to produce AB and B. In conclusion, firm 2 prefer to "license without competition."

One step back to the initial phase 1, firm 1 is required to consider selling a bundle AB or not. The only difference between bundling and separate sales is the profit of the single patent firm when they do not reach at a license agreement. Bundling leverages a part of monopoly power to competitive market, which weakens the profitability of the opposing firm 2. Reducing the profit of the opponent, firm 1 holds a better position when it comes to the bargaining of license.

Therefore, the multiple right holder makes a bundle at the first stage to erode the position of the single right holder at the following second stage. Firm 2 complies with the license agreement and only firm 1 is operating in the end. Firm 2 may try to breach the contract coming back to the market B but it cannot enjoy any positive profit as long as firm 1 still offers a single product B with the same quality of firm 2.

Proposition: In the equilibrium, firm 1 introduces a bundle AB with a single product B. Firm 2 made a license contract not operating in the market. Finally, only firm 1 is acting as a monopoly in both markets, no matter what kinds of commodities are offered.

The above proposition stipulates that the single patent firm with superior technology, in fact, sells it to the multi-patent firm. To promote this kind of selling, the multi-patent firm utilizes the bundling strategy to deteriorate the standalone firm's bargaining position. In equilibrium, the multi-patent firm is the only one that produces all the products while buying all the innovative technology. When the proposition applies to a business group that acts in many different markets, the result implies that bundling might be useful means to drive out stand-alone firms. Industrial structure might seem to be monopolized by the multi-company group when the group is purchasing the good businesses run by the stand alones.

Followed is a numerical example with various value of α that measures the single right holder's technological superiority.

<Table 1> Numerical Examples with various value of superiority α

VALUE	SEPARATION				BUNDLE			
α	π^1		π^2		π^1		π^2	
techno. improve-ment	comp. w/o licen.	licen. w/o comp.	comp. w/o licen.	licen. w/o comp.	comp. w/o licen.	licen. w/o comp.	comp. w/o licen.	licen. w/o comp.
0	0.25	0.375	0	0.125	0.25	0.5	0	0.125
0.1	0.25	0.3513	0.1	0.2013	0.25	0.5012	0.05	0.1763
0.2	0.25	0.33	0.2	0.28	0.25	0.505	0.1	0.23
0.3	0.25	0.3112	0.3	0.3613	0.25	0.5112	0.15	0.2863
0.4	0.25	0.295	0.4	0.445	0.25	0.52	0.2	0.345
0.5	0.25	0.2813	0.5	0.5313	0.25	0.5313	0.25	0.4063
0.6	0.25	0.27	0.6	0.62	0.25	0.545	0.3	0.47
0.7	0.25	0.2612	0.7	0.7113	0.25	0.5613	0.35	0.5363
0.8	0.25	0.255	0.8	0.805	0.25	0.58	0.4	0.605
0.9	0.25	0.2512	0.9	0.9013	0.25	0.6013	0.45	0.6763
1	0.25	0.25	1	1	0.25	0.625	0.5	0.75
1.1	0.25	0.2513	1.1	1.1013	0.25	0.6513	0.55	0.8263
1.2	0.25	0.255	1.2	1.205	0.25	0.68	0.6	0.905
1.3	0.25	0.2612	1.3	1.3113	0.25	0.7113	0.65	0.9863
1.4	0.25	0.27	1.4	1.42	0.25	0.745	0.7	1.07
1.5	0.25	0.2813	1.5	1.5313	0.25	0.7813	0.75	1.1563
1.6	0.25	0.295	1.6	1.645	0.25	0.82	0.8	1.245
1.7	0.25	0.3112	1.7	1.7613	0.25	0.8612	0.85	1.3362
1.8	0.25	0.33	1.8	1.88	0.25	0.905	0.9	1.43
1.9	0.25	0.3512	1.9	2.0012	0.25	0.9512	0.95	1.5262
2	0.25	0.375	2	2.125	0.25	1	1	1.625
2.1	0.25	0.4013	2.1	2.2513	0.25	1.0513	1.05	1.7263
2.2	0.25	0.43	2.2	2.38	0.25	1.105	1.1	1.83
2.3	0.25	0.4612	2.3	2.5112	0.25	1.1612	1.15	1.9362
2.4	0.25	0.495	2.4	2.645	0.25	1.22	1.2	2.045
2.5	0.25	0.5313	2.5	2.7813	0.25	1.2813	1.25	2.1563
2.6	0.25	0.57	2.6	2.92	0.25	1.345	1.3	2.27
2.7	0.25	0.6113	2.7	3.0613	0.25	1.4113	1.35	2.3863
2.8	0.25	0.655	2.8	3.205	0.25	1.48	1.4	2.505
2.9	0.25	0.7012	2.9	3.3512	0.25	1.5513	1.45	2.6262
3	0.25	0.75	3	3.5	0.25	1.625	1.5	2.75

This paper does not deal with consumer's surplus or social welfare while focusing on the producer's strategy. Welfare comparison will help the regulator guide the industry in order to determine anti-competitiveness. Since the model this paper bears on is a stripped simple model, more sophisticated consideration would be required for practical use.

Technically, the result of this paper draws upon uniform distribution of preference types and additive separable augmentation of technological improvement. To ascertain the results in the proposition, we need to test the validity in various types of distribution. For instance of Schmalensee (1984), Gaussian distribution or truncated normal distribution might be testable. If the generalization is achievable under well known distributions, we can accommodate the dependence among product valuations since it is directly related to the complementary or substitutable goods.

Typical effects such as price discrimination and entry deterrence are ignored. Combining those effects into this setup, what would be of importance might be compared. Or the robustness of strategic bundling for license is required to be investigated again.

References

Adams, W., & Yellen, J. (1976). Commodity Bundling and the Burden of Monopoly. *Quarterly Journal of Economics,* 90(3), 475-498.

Aoki, R., & Tauman, R. (2001). Patent Licensing with Spillovers. *Economics Letters,* 73(1), 125-130.

Bakos, Y., & Brynjolfsson, E. (1999). Bundling Information Goods: Pricing, Profits, and Efficiency. *Management Science,* 45(12), 1613-1630.

Bhattacharya, S., Glazer, J., & Sappington, D. E. (1992). Portfolio Choice in Research and Development. *RAND Journal of Economics,* 17(4), 594-605.

Brocas, I. (2003). Optimal Regulation of Cooperative R&D under Incomplete Information. *Journal of Industrial Organization,* 21(1), 457-488.

Cockburn, I., & Henderson, R. (2003). *Survey Results from the 2003 Intellectual Property Owners Association Survey on Strategic Management of Intellectual Property.* Retrieved May 21, 2014, from http://www.ipo.org/wp-content/uploads/2013/04/survey_results_revised.pdf

d'Aspremont, C., & Jacquemin, A. (1988). Cooperative and Noncooperative R&D in Duopoly with Spillovers. *American Economic Review,* 78(5), 1133-1137.

Gandal, N., & Scotchmer, S. (1993). Coordinating Research through Research Joint Ventures. *Journal of Public Economics,* 51(2), 173-193.

Gilbert, R., & Sunshine, G. C. (1995). The Use of Innovation Markets: A Reply to Hay, Rapp and Hoerner. *Antitrust Law Journal,* 64(1), 75-82.

Kamien, M. I., Tauman, Y., & Zang, I. (1988). Optimal Licensing Fees for a New Product. *Mathematical Social Science,* 16(1), 77-106.

Katz, M., & Shapiro, C. (1987). R & D Rivalry with Licensing or Imitation. *American Economic Review,* 77(3), 402-420.

Kim, N.-M., & Youn, M.-K. (2014). Global Distribution Enterprises' Entry into the Chinese Market: Focus on the Three Northeastern Provinces. *International Journal of Industrial Distribution & Business,* 5(3), 25-34.

La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (1999). Corporate Ownership around the World. *Journal of Finance,* 54(2), 471-517.

Lee, J. W. (2014). The Impact of Product Distribution and Information Technology on Carbon Emissions and Economic Growth: Empirical Evidence in Korea. *Journal of Asian Finance, Economics and Business,* 1(3), 17-28.

Lewbel, A. (1985). Bundling of Substitutes or Complements. *International Journal of Industrial Organization,* 3(1), 101-107.

McAfee, R., McMillan, J., & Whinston, M. (1989). Multiproduct Monopoly, Commodity Bundling, and Correlation of Values. *Quarterly Journal of Economics,* 104(2), 371-383.

Nalebuff, B. (2004). Bundling as an Entry Barrier. *Quarterly Journal of Economics,* 119(1), 159-187.

Nash, J. (1950). The Bargaining Problem. *Econometrica,* 18(2), 155-162.

Schmalensee, R. (1984). Gaussian Demand and Commodity Bundling. *Journal of Business,* 57(1), s211-230.

Solow, R.M. (1956). A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics,* 70(1), 65-94.

Solow, R. M. (1957). Technical change and the aggregate production function. *Review of Economics and Statistics,* 39(3), 312-320.

Stigler, G. J. (1963). United States v. Loew's Inc.: A Note on Block-Booking. *Supreme Court Review,* 1963, 152-157.

Suzumura, K. (1992). Cooperative and Noncoopertive R&D in an Oligopoly with Spillovers. *American Economic Review,* 82(5), 1307-1320.

U.S. Department of Justice & Federal Trade Commission (1995). *Antitrust Guidelines for the Licensing of Intellectual Property.* Washington, DC: Department of Justice and Federal Trade Commission.

Whinston, M. (1990), Tying, Foreclosure, and Exclusion. *American Economic Review,* 80(4), 837-859.