E C O N O M I C S   B U L L E T I N

Technology Licensing to a Rival

Caroline Boivin
University of Sherbrooke

Corinne Langinier
Iowa State University

Abstract

Licensing a new technology implies introducing competition into the market. This has a negative effect on the profit of the incumbent if the demand remains unchanged. However, because of the novel content of an innovation, consumers may have different perceptions of the value of a good depending on the market structure. Thus, the introduction of a competitor into the market may enhance demand, and consequently have a positive effect on the profit of the incumbent. In a simple setting, we show that the incumbent may decide to license her technology even in the absence of a royalty when the positive effect outweighs the negative one.

Citation: Boivin, Caroline and Corinne Langinier, (2005) "Technology Licensing to a Rival." *Economics Bulletin,* Vol. 12, No. 14 pp. 1−8
Submitted: July 7, 2005. **Accepted:** September 19, 2005.
URL: http://www.economicsbulletin.com/2005/volume12/EB−05L10021A.pdf

1 Introduction

Technology licensing is generally viewed as a revenue-generating device. It might be a way of ensuring that a technology will be commercialized by a more efficient firm (e.g., a firm that has a better distribution system in place). In return for the use of her technology, the innovator gets a reward in the form of royalties (Tirole 1988). Even if an innovator sells her own products, it may also be profitable to license a technology that would be incorporated into a product offered in an independent market where the marketing skills of the innovator may not be as strong. In this way, the license has no competitive impact but generates additional revenues for the innovator.

Licensing may also be used for strategic considerations. Rockett (1990) shows that an innovator may use technology licensing to prevent the entry of strong competitors. Before her patent expires, the innovator licenses the technology to weaker competitors. These firms have some time to get a foothold in the market before others can join, and then ultimately, this discourages later entrants. Licensing thus enables the innovator to choose her competitors. Licensing may also be a way to impose a technology on a market where incompatible technologies are candidates to become a standard. The aggressive licensing strategy used by VHS patent holders certainly contributed to the victory of the VHS technology over Betamax on the video market. Many firms have also recognized that cross-licensing is mutually beneficial in order to ensure that the introduction of a technology will not be blocked. This is especially true in markets such as telecommunications, where new products or services incorporate a large number of patented innovations.

Licensing may have a positive impact on demand, so that there may be benefits to licensing in terms of market expansion. Shepard (1987) and Farrell and Gallini (1988) show that licensing may stimulate demand, since consumers would not fear being victims of opportunism on the incumbent's part because she faces competition. Shepard (1987) demonstrates that licensing acts as a guarantee of the quality of the products, while Farrell and Gallini (1988) show that licensing prevents future price increases. Although these benefits may be substantial, these studies do not consider that an increase in demand may be sufficient to ensure the profitability of a licensing strategy.

Conner (1995) goes further in the analysis of the benefits of market expansion from licensing. She determines the conditions under which it is profitable for an incumbent to license her technology for free to an entrant that will use the technology to introduce his own product and compete on the incumbent's market. She shows that licensing is a profit-maximizing strategy when network externalities are strong enough, but only if the quality of the entrant's products is lower than the quality of the incumbent's products. Under these circumstances, the licensee covers the inferior portion of the market that consists of consumers with low valuations of the product. Thus, the licensee does not steal many customers from the incumbent, and the presence of network externalities results in an increase in willingness-to-pay of the incumbent's customers.

We follow in Conner's footsteps in suggesting that the increase in demand resulting from licensing may be large enough to induce an innovator to share her technology. Our results establish that it may be profitable for a firm to license her technology to a rival who would compete in the same market in a homogenous-product duopoly setting, even without royalties. Whereas, in much of the licensing literature, it is assumed that the licensor does not market the technology (e.g., Bousquet et al., 1998), we consider an innovator who markets her technology and can also license it to another firm.

The paper is organized as follows. The model is presented in section 2. We first determine the demand and define the equilibrium quantities and payoffs. In section 3 we study the licensing behavior of the leader in absence of royalties. Section 4 concludes.

2 The Model

We consider a two-period model in which an incumbent (leader) has to decide whether to share her technology via a license with a potential licensee (follower).

The timing of the game is as follows:

- First, the leader decides whether to license her technology. The follower then accepts it or not.

- In the second stage, if both firms are in the market, they decide their production level in a Cournot competition.

Using a backward induction argument, we first determine the quantity offered by each firm, depending on the structure of the market and on the demand. Second, we determine whether the follower accepts the technology.

Demand plays an important role in our setting, as the structure of the market directly influences the demand. We assume that consumers have different perceptions of the value of the good depending on whether only one firm offers the good or two firms offer two similar goods. We first present the detailed demand structure, before turning to the competition stage.

2.1 Consumers' Behavior and Demand

The perception of the value of a good is based not only on its intrinsic characteristics, but also on marketing cues. This is especially true for new products whose characteristics and performance are still unknown to consumers. For instance, Moorthy and Zhao (2000) find that advertising expenditures and perceived quality are generally positively correlated. Advertising may act as a signal that the firm believes enough in the product to devote financial resources to its promotion. The signal of quality may, thus, be even stronger if another firm enters the market and promotes the product.

The demand structure is affected by the decision of the follower to enter or not. Consumers value differently the good offered by a single firm, and the goods offered by two firms. We assume a simple framework in which each consumer consumes 0 or 1 unit of the good. The good is characterized by an index s that represents the perception of the value of the good by consumers. A consumer who is not willing to buy a product offered by a monopoly may be willing to buy it once he can observe that another firm has decided to market the technology. The fact that another firm is backing the technology is a signal of the value of the good to the consumer. If the product is just offered by the monopoly, the perception of the value by consumers is s_m, whereas if another firm has entered the market, it becomes s_d. To keep the model as general as possible, we impose no restrictions on the relationship between s_m and s_d. If the value of the good is positively related to the number of firms on the market then $s_d > s_m$.

The utility of a consumer is

$$U = \begin{cases} \theta s_m - p_m & \text{if a monopoly serves the market, and the consumer buys at price } p_m, \\ \theta s_d - p_d & \text{if a duopoly serves the market, and the consumer buys at price } p_d, \\ 0 & \text{if the consumer does not buy,} \end{cases}$$

where θ represents the taste parameter of the consumer and is distributed according to a density function $f(\theta)$ with a cumulative function $F(\theta)$. $F(\theta)$ represents the fraction of consumers with a taste parameter inferior to θ. We assume that θ is distributed uniformly on $[0, 1]$.

If there is no entry, the leader has a monopoly position in the market. Consumers with utility smaller than 0 do not buy. Thus, $\theta < p_m/s_m$ represents the fraction of consumers who do not buy the good and the demand for the monopoly is $D_m(p_m) = N[1 - F(p_m/s_m)]$, where N is the total number of consumers that we normalize to be 1. As we assume a uniform distribution, the demand function for the monopoly is $D_m(p_m) = 1 - p_m/s_m$ and the inverse demand function becomes

$$p_m(q) = s_m(1 - q). \tag{1}$$

If the follower accepts the license, the structure of the market is a duopoly. The fraction of consumers who buy the product increases by $[F(p_m/s_m) - F(p_d/s_d)]$, and thus, the new demand becomes $D_d(p_d, p_m) = 1 - F(p_m/s_m) + F(p_m/s_m) - F(p_d/s_d)$, which gives the inverse demand function

$$p_d(q) = s_d(1 - q). \tag{2}$$

2.2 Competition in Quantity

We now derive the quantities provided by the firms when there is no technology licensing (monopoly) and when there is technology licensing (duopoly).

2.2.1 Monopoly

If the follower does not enter, the leader has a monopoly and the demand is given by (1). Thus, the monopoly maximizes her profit $\Pi^m = p_m(q)q - c_1 q$, where c_1 is the cost of production per unit. The monopoly quantity is $q_m = (s_m - c_1)/2s_m$, where $c_1 < s_m \leq 3c_1$,[1]

[1] We assume that the leader's cost of production is relatively high.

and the monopoly price is $p_m = (s_m + c_1)/2$. The monopoly profit is

$$\Pi^m = \frac{(s_m - c_1)^2}{4s_m}. \tag{3}$$

2.2.2 Duopoly

If the follower accepts the license offered for free by the leader, both firms compete in quantity (Cournot competition) and the demand is given by (2). The profit of each firm is

$$\begin{aligned} \Pi_1^d &= p_d(q_1, q_2)q_1 - c_1 q_1, \\ \Pi_2^d &= p_d(q_1, q_2)q_2 - c_2 q_2, \end{aligned}$$

where c_2 is the per unit cost of production of the follower. The profit maximization gives the following quantities

$$q_1 = \frac{s_d - 2c_1 + c_2}{3s_d}, \tag{4}$$

$$q_2 = \frac{s_d - 2c_2 + c_1}{3s_d}, \tag{5}$$

where $s_d > 2c_1 - c_2$ and $s_d > 2c_2 - c_1$. The duopoly price is $p_d = (s_d + c_2 + c_1)/3$. The optimal profit of each firm is

$$\Pi_1^d = \frac{(s_d - 2c_1 + c_2)^2}{9s_d}, \tag{6}$$

$$\Pi_2^d = \frac{(s_d - 2c_2 + c_1)^2}{9s_d}. \tag{7}$$

3 Licensing Decision

We only consider the case in which the leader licenses her technology for free. This enables us to isolate two opposite effects of technology licensing. From the leader's point of view, technology licensing first has a negative impact on her profit, since her market share decreases. Second, as demand may increase with the entry of another firm, there is also a potential positive effect on her profit resulting from the expansion of the market. The positive impact may then compensate for the erosion in market share and make licensing attractive, even when it does not bring in additional revenues in the form of dividends.

In this setting, each firm gets a duopoly payoff $\Pi_i^d = (s_d - 2c_i + c_j)^2/9s_d$, where $i, j = 1, 2$ and $i \neq j$, for producing at least the minimum quantity that can be detected by consumers on the market. Indeed, the demand is defined by the consumers' perceived value of the good, which is, in turn, influenced by the number of firms. To convince consumers that they are present in the market, firms must produce at least a minimum quantity, that we denote κ, and we further assume that $\kappa < 1/3$. The follower accepts a license as long as he gets a positive profit, i.e., $\Pi_2^d > 0$. The leader decides to license her technology if it is worthwhile, as the introduction of a new firm in the market has a positive impact on profits if demand increases sufficiently. Formally, the leader licenses as long as

$$\Pi_1^d > \Pi^m. \tag{8}$$

Furthermore, both firms need to produce at least κ to inform consumers that two firms are producing, or equivalently, $s_d \geq (2c_1 - c_2)/(1-3\kappa) \equiv f_1(c_2)$ and $s_d \geq (2c_2 - c_1)/(1-3\kappa) \equiv f_2(c_2)$ must be satisfied.[2]

Inequality (8) holds for certain constellations of parameters (s_d, c_2). Indeed, as long as the introduction of a competitor does not increase demand, i.e., $s_d < s_m$, the monopoly licenses her technology if $s_d > (3s_m + c_1)/2 - c_2 \equiv \varphi(c_2)$. On the other hand, if $s_d \geq s_m$, for high values of the follower's cost (i.e., $c_2 > 2c_1$), the monopoly always licenses, whereas for lower values (i.e., $c_2 \leq 2c_1$), she licenses only if $s_d > \phi(c_2)$ where $\phi(c_2)$ is defined in the appendix.

Overall, licensing occurs if $(s_d, c_2) \in \{(s_d, c_2)/s_d \geq \phi(c_2)$ and $s_d \geq f_2(c_2)\}$. We represent in a graph (s_d, c_2) the areas where technology licensing occurs.

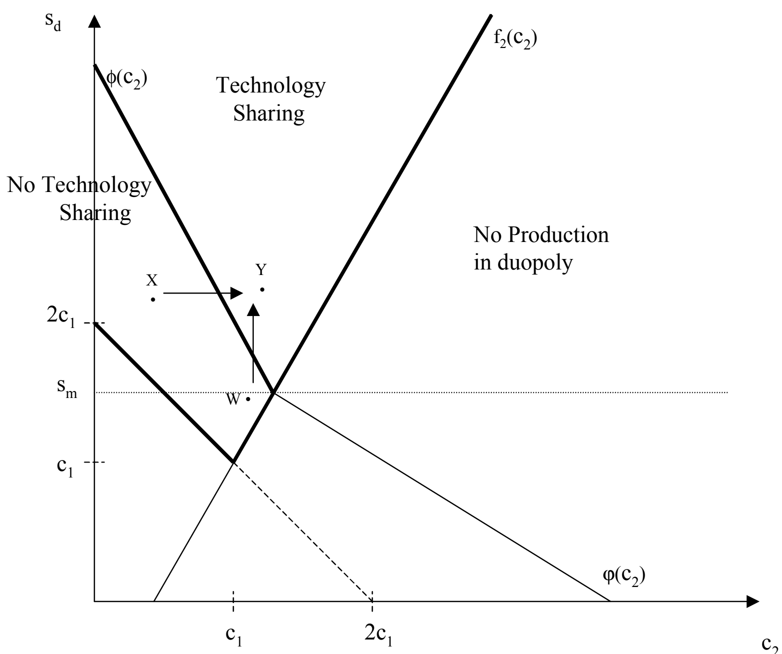

Figure 1: Licensing for free, $s_m \leq 3c_1$

Consider a given high enough s_d (i.e., $s_d > s_m$), as represented by point X in figure 1. At this point, the leader does not share her technology and enjoys a monopoly profit. If the cost of production of the follower increases from point X to point Y, the leader

[2]Those conditions are more restrictive than the conditions on positive quantities.

now shares her technology, and thus gets a duopoly profit. As the cost of production for her competitor increases, the leader is more willing to share her technology, as she will produce more than the licensee. On the other hand, if we consider a given level of cost c_2 (point W in figure 1), and s_d increases, we go from a regime where the leader does not share her technology to a regime where she does. This is because the entry of a competitor enhanced the demand enough. This can happen even if the follower's cost of production is low. Thus, there are two effects: a demand effect and a cost effect.

Result *The leader licenses her technology for free when the entry of a competitor sufficiently enhances demand, and/or his cost of production is high enough, i.e., for* $s_d \geq \max\{\phi(c_2), \varphi(c_2)\}$. *The follower only accepts the technology licensing if* $s_d \geq f_2(c_2)$.

Even in the absence of royalties, the leader finds it profitable to license her technology when the introduction of a competitor increases the demand. As Figure 1 illustrates, the leader's incentive to license her technology depends on: (i) the change in the consumers' perception of the value; (ii) the relative cost of production.

When there is a low cost of production for the follower, the leader prefers to keep her monopoly position unless the demand stimulation is large. If the follower has a cost advantage, the leader expects a large decrease in her market share following the entry of a rival. The demand stimulation thus must be high in order to compensate for the erosion of the market share. As the follower's cost advantage decreases, the demand stimulation necessary to make licensing profitable for the innovator also decreases. In the case of higher cost of production for the follower, and if the follower produces, the leader prefers to license her technology. The same logic may be used to explain the intuition of the result. If the leader has a cost advantage, she expects only a small reduction of her market share following the entry of a rival. A small demand stimulation is thus sufficient to compensate for the reduction in the market share and to make licensing attractive. As the follower's cost of production increases, technology sharing is less likely to occur, since the profitability of the follower's entry decreases.

We also need to consider the behavior of the firms when $s_d < f_1(c_2)$ (the duopoly quantity of the leader is smaller than κ) and/or $s_d < f_2(c_2)$ (the duopoly quantity of the follower is smaller than κ). In the former case (respectively, the latter case), the leader (respectively, the follower) can decide to produce κ or to produce less, and thus, the demand is no longer represented by (2) but by (1). Indeed, if one of the quantities is too small, consumers cannot correctly infer that two firms are in the market, and they have the demand (1). However, the leader is better off by keeping her monopoly position, i.e., by not licensing her technology in the first place. When the minimum quantity κ increases, the area where the leader shares her technology shrinks as the function $f_2(c_2)$ rotates to the left around $c_1/2$.

Thus, the leader shares her technology if (i) the demand enhancement is large enough and/or (ii) the cost for the follower is not too large, and finally (iii) if neither firm has to produce too much to signal his or her presence in the market.

4 Conclusion

Our results establish that it may be profitable for a firm to license a product innovation to a rival that would compete on the same market in a homogenous-product duopoly setting even without royalties. The profitability of licensing is directly linked to demand stimulation brought about by a potential increased in perceived quality by consumers following the entry of a second firm on the market.

These results are especially valuable for firms introducing new products on the market since the presence of a rival may act as a signal of quality and thus enhance demand. Trying to avoid competition may not thus be the best strategic prescription.

References

Bousquet, A. H. Cremer, M. I. and M. Wolkowicz (1998). Risk sharing in licensing. *International Journal of Industrial Organization 16*, 535–554.

Conner, K. (1995). Obtaining stratgeic advantage from being imitated: When can encouraging clones pay? *Management Science 41*, 209–225.

Farrell, J. and N. Gallini (1988). Second sourcing as a commitment: Monoploy incentives to attract competition. *Quarterly Journal of Economics 103*, 673–694.

Moorthy, S. and H. Zhao (2000). Advertising spending and perceived quality. *Marketing Letters 11:3*, 221–233.

Rockett, K. (1990). Choosing the competition and patent licensing. *International Journal of Industrial Organization 21*, 161–171.

Shepard, A. (1987). Licensing to enhance demand for new technologies. *RAND Journal of Economics 18*, 360–368.

Tirole, J. (1988). *The Theory of Industrial Organization*. MIT press.

Appendix

The leader licenses as long as $\Pi_1^d > \Pi^m$, where Π^m and Π_1^d are defined by equations (3) and (6). If $s_d < s_m$, $\Pi_1^d > \Pi^m$ as long as $s_d > (3s_m + c_1)/2 - c_2$. On the other hand, if $s_d \geq s_m$, $\Pi_1^d > \Pi^m$ is equivalent to having $q_1^2 s_d > q_m^2 s_m$ and, thus, we only need to verify that $q_1 > q_m$. This last inequality is equivalent to $2s_m(-2c_1 + c_2) > s_d(s_m - 3c_1)$. Depending on the signs of $(-2c_1 + c_2)$ and $(s_m - 3c_1)$, this inequality does holds. As we assume that $s_m \leq 3c_1$, if $c_2 > 2c_1$, $\Pi_1^d > \Pi^m$, whereas if $c_2 \leq 2c_1$, $\Pi_1^d > \Pi^m$ only if $s_d \geq \phi(c_2)$, where $\phi(c_2) = \frac{1}{8s_m}(8(-s_m c_2 + s_m^2 + c_1^2) + (s_m - c_1)^2 - 3(s_m - c_1)\sqrt{(3s_m + 3c_1)^2 - 4s_m(c_1 + 4c_2)})$. Indeed, $(s_d - 2c_1 + c_2)^2/9s_d - (s_m - c_1)^2/4s_m > 0$ if $s_d < \phi'(c_2)$ and $s_d > \phi(c_2)$, where $\phi'(c_2) = \frac{1}{8s_m}(8(-s_m c_2 + s_m^2 + c_1^2) + (s_m - c_1)^2 + 3(s_m - c_1)\sqrt{(3s_m + 3c_1)^2 - 4s_m(c_1 + 4c_2)})$. We can check that $\phi(c_2)$ is a decreasing and convex function.