Licensing innovation under strategic delegation: the price competition case

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INTRODUCTION:

A firm that invests in research and development has the opportunity to reap a reward using the innovation or licensing it: if the innovator is a research laboratory or a university, it recovers the investment by licensing the new technology to firms operating in the market, instead, if it is a producing patent holder, it can use this advantage for its production and it can decide to license it to its competitors by generating licensing revenues. Different types of licensing contracts are available: **auction** (if the innovation is licensed to a limited number of firms through a bid auction), **fee licensing** (offering a lump-sum licensing fee), **royalty licensing** (offering a royalty payment for every unit produced by the licensee) or **two part tariff** (a mix of a fixed amount and a variable part).
All the traditional patent-licensing literature considers firms as economic agents with the sole objective of profit maximization. During the last couple of decades, economists began to take in consideration that the modern corporation is characterized by a separation of ownership and management: the new objective function begins to focus on managerial objectives. In this setting the owner-manager relationship is very important and it is a standard principal-agent problem where **the manager's objective function is linked to the structure of incentives designed** by the owner to motivate him.
Managers are called to make decisions on the product market on the basis of a delegation chosen optimally by owners who pursue profit maximization objectives. The delegation gives each manager the ability to act on the market by maximizing sales (or another variable of interest for the manager) rather than profits in a certain measure.

THE BACKGROUND:

The main literature analyzing license agreements in the case of **strategic delegation shows that strategic delegation reduces the probability of licensing with respect to the case of no-delegation**. The works below analyze **competition** in the case of an **homogeneous product** and use the following Fershtman and Judd (1987) objective function:

$$R_i = \alpha_i \Pi_i + (1 - \alpha_i) S_i$$

where Π_i and S_i are the profits and the revenues of the ith firm. The manager contract is $A_i + B_i R_i$ where A_i and B_i are constants and are chosen by owners to ensure that in equilibrium $A_i + B_i R_i$ is equal to the manager's reservation income Y_i.
If X_i is th amount that the owner can earn elsewhere after assuming the manager, following Basu (1995), the cost of hiring a manager can be expressed $Z_i = Y_i - X_i$.

MUKHERJEE (1999)

It studies technology transfer of a **cost-reducing innovation** in a **duopoly** where t**he innovator is inside the market**. In the first stage of the game the innovator decides to license the new technology to its competitor through fixed fee and in the second stage each firm decides whether to hire a manager or not. If owner assumes a manager, after the choice of the manager's objective function (in the third stage), managers face **Cournot competition** and decide how much to produce in the fourth stage.
It studies the probability of **licensing with fixed fee** for the different values of Z_i, assuming that this cost is the same for both firms:
- if the costs of hiring a manager are prohibitive, neither firm hires a manager.
- if the costs of delegation are negligible, the probability of technology trasfer is minimal compared and less than in the no incentive delegation model.
- if Z_i are significant, but not so costly that neither firm prefers to hire a manager (the equilibrium in case of no-licensing is (0.1), while (0.0) is the equilibrium in case of no-licensing) licensing is always profitable.

HSU-WANG (2004)

It analyzes licensing agreements of a **cost-reducing innovation** in a simple model, a **duopoly** where the patentee is also a competitor in the market of the final product. For simplicity it focuses on **non-drastic innovation** and it analyzes a three-stage game: in the first stage the owners of the two firms simultaneously decide incentive contracts for their managers; in the second stage the patent-holder decides to license or not to license the new technology and the rival evaluates the convenience to accept or not to accept the licensing contract; in the last stage, firms compete on in the product market and they face **Cournot competition**.
It demonstrates that with strategic delegation, technology licensing is profitable for lower technology initial differences between the firms respect to no-delegation model. It shows this result both with fixed fee and with royalty, comparing its results with those obtained by Wang (1999) in the same model, but without strategic delegation. The analysis is carried out under the assumption that Z_i is zero.

SARACHO (2002)

It introduces the strategic delegation in the model of Kamien and Tauman (1986): a **research lab (external innovator)** sells licenses of a **process innovation** that is able to reduce the cost of production of the final product. The analysis develops in the following stages: in the first stage the patent-holder decides whether to adopt fixed fee or royalty, in the second stage all firms simultaneously decide whether or not to buy the licensee, in the third stage, all firms decide on the manager compensation incentives and finally in the fourth stage firms complete in a **quantity competition game**. The first part of the work proves the superiority of royalty licensing over the fixed fee licensing from the point of view of the patentee if there are two potential licensees. It also expands the analysis in the case of an **oligopolistic market** and shows that royalty can be more profitable than fixed fee if the number of potential licensors is small enough.
In this setting it shows that when the patentee **licenses with fixed fee**, strategic delegation slows down the diffusion of the innovation. In this work, it is assumed that the cost of hiring a manager Z_i is zero.

OBJECTIVES:

We use a three stage game to study the influence of strategic delegation on the probability that a patent-holder (a competitor in the market or an outsider innovator) decides to license or not to license its new innovation to others firms. The analysis is carried out under the assumption that Z_i is zero. We analyze three different settings separately with a **differentiated product** and we show that **if firms face Bertrand competition, the probability of licensing increases**. This contrasts with the result that we observe with quantity competition, consistent with the literature above, because **if firms face Cournot competition, strategic delegation slows down the diffusion of the licensees**. Our game takes place in the following stages:
- at the first stage, the innovator decides to license or not to license its technology and the potential licensees decide to accept or not to accept the licensing agreement.
- at the second stage, the firms' owners decide simultaneously their incentive contract for their managers.
- at the last stage of the game the firms' managers simultaneously compete on the downstream market.

RESULTS:

CASE 1: PRODUCT INNOVATION WITH AN INTERNAL PATENT-HOLDER

1

We analyze a **duopoly** with a **differentiated product** where one of the two firms has a **product innovation** that can decide to license to its rival: it can choose the optimal license contract between royalty or fixed fee. If the innovator does not license the new technology, it remains monopolist on the market. We carry out the analysis in case of Cournot and Bertrand competition.
We observe that, as in absence of strategic delegation, both in Cournot and in Bertrand, when the products are sufficiently differentiated, it is more convenient to license with fixed fee (the firm 1 obtains high profits on its market and estrapolates the results obtained by the firm 2 through F), while when goods become more similar, royalty is the optimal licensing contract. Instead royalty is the only one that can be used when the product differentiation parameter is very high: it is always profitable to license with royalty respect to non-licensing, with strategic delegation and without it, both in case of Bertrand and Cournot competition. In this case the patent-holder has a cost advantage because the rival has to pay a royalty for each unit sold. Licensing the new technology, the innovator will certainly have a loss in market profit, but it is competitively stronger than the rival, so even if the products are very similar, its market profits will not fall dramatically and it's always advantageous to license with royalty.
We have also compared the results with fixed fee licensing obtained in this setting with those in the same model but in the absence of delegation. Below we present briefly the results that show as with Bertrand competition and strategic delegation, the width of the product differentiation parameter range increses, making the licensing more profitable.

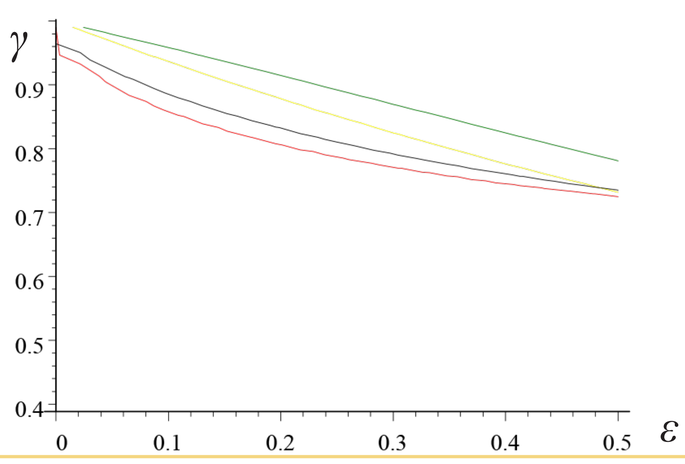
COURNOT competition	BERTRAND competition
LICENSING WITH FIXED FEE	**LICENSING WITH FIXED FEE**
XX	$\Pi_i^F > \Pi_i^{NL}$
• With strategic delegation	• With strategic delegation
$\gamma < 0{,}701$	$\gamma < 0{,}672$
• Without strategic delegation	• Without strategic delegation
$\gamma < 0{,}828$	$\gamma < 0{,}611$
In case of Cournot competition, the probability of licensing decreases	**In case of Bertrand competition, the probability of licensing increases**

CASE 2: PROCESS INNOVATION WITH AN INTERNAL PATENT-HOLDER

2

We analyze a model of **duopoly** in which one of the two firms invests in research and development and has a **process innovation** that allows it to reduce the cost of production of the final good: in this setting we work under the hypothesis of **non-drastic innovation** (the magnitude of the innovation is not so large that the rival comes out from the market if it does not obtain the innovation).
We demonstrate that it is always profitable to license with royalty while it is always profitable to license with fixed fee only for not too high values of the product differentiation parameter. If products are more similar, the convenience is linked to the magnitude of the innovation: the width of the innovation that makes licensing profitable becomes smaller with the increase of the product differentiation parameter. When we compare the two types of licensing, royalty and fixed fee, we observe that if the products are sufficiently differentiated, licensing with fixed fees is the optimal strategy.
To study the influence of strategic delegation on the probability that licensing occurs, it is necessary to graphically compare profit differentials in case of delegation and in case of non-delegation (Wang-Yang, 1999), as follows:

COURNOT competition
LICENSING WITH FIXED FEE

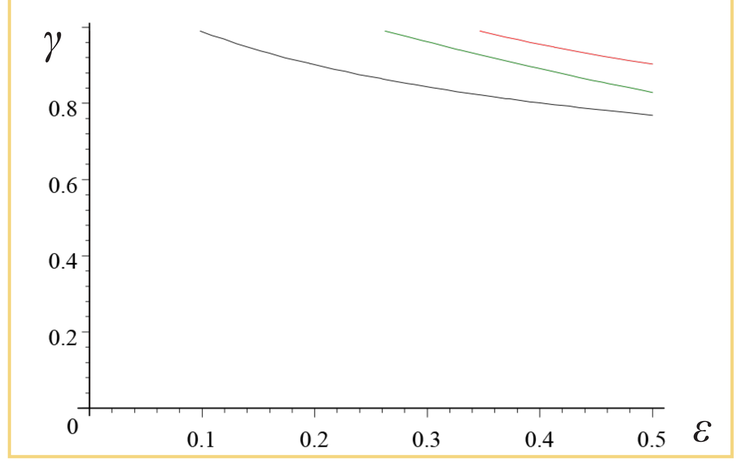


γ = Product differetiated parameter
ε = Magnitude of innovation

The delegation curve (black curve) is below the delegation curve (red curve) and the profit differential is positive is the area below the curves.

In case of Cournot competition, the probability of licensing decreases.

BERTRAND competition
LICENSING WITH FIXED FEE



γ = Product differetiated parameter
ε = Magnitude of innovation

The delegation curve (black curve) is above the delegation curve (red curve) and the profit differential is positive is the area below the curves.

In case of Bertrand competition, the probability of licensing increases.

Profit differential ($\Pi_i^F - \Pi_i^{NL}$) in absence of strategic delegation.

Profit differential ($\Pi_i^F - \Pi_i^{NL}$) in case of strategic delegation.

Condition on non drastic innovation in case of strategic delegation.

Condition on non drastic innovation in absence of strategic delegation.

CASE 3: PRODUCT INNOVATION WITH AN EXTERNAL PATENT-HOLDER

3

We assume that a firm invests in research and develops a **new product** that can license to ***n* potential licensees** that adopt strategic delegation (where n is exogenously determined). The innovator adopts a bid auction as licensing contract: it sells licenses simultaneously and each bidder can win at most one license. We indicate with $1 \le k \le n$ the effective number of licenses (it is an endogenous variable in the model).
We prove that royalty can dominate auction (also fixed fee because if the profit of the licensee would be zero in the case of non-licensing, royalty is equivalent to fixed fee policy) both in Cournot and in Bertrand if the number of potential licensors is sufficiently large.
To understand how strategic delegation influences the diffusion of innovation in case of auction, we analyze for a given value of the product differentiation parameter the optimal choice of the innovator: the number of firms to which the patent-holder licenses the innovation in case of strategic delegation and without delegation (Bagchi, Mukherjee, 2013).

COURNOT competition	BERTRAND competition
LICENSING WITH AUCTION	**LICENSING WITH AUCTION**
$\Pi_i^A > \Pi_i^{NL}$	$\Pi_i^A > \Pi_i^{NL}$
$\gamma = 0{,}1$	$\gamma = 0{,}1$
• With strategic delegation	• With strategic delegation
$k = 18$	$k = 18$
• Without strategic delegation	• Without strategic delegation
$k = 19$	$k = 17$
In case of Cournot competition, strategic delegation reduces the number of licensees to which innovator grants the license.	**In case of Bertrand competition, strategic delegation increases the number of the effective licensees.**

DISCUSSION:

We have shown that **in the case of Bertrand competition strategic delegation increases the probability that licensing occurs, while in case of Cournot competition the delegation reduces the probability that licensing takes place**. This is strictly linked to the different behavior of owners in the two types of competition: if firms compete with Bertrand, the owners discourage managers to behave aggressively on the market through an overcompensation of profits, while in the case of Cournot competition managers are encouraged to be aggressive on the market.
To better understand, we consider the simplest model of product innovation with a patentee that is a competitor on the market and licenses with fixed fee (case 1). In case of Cournot competition, hiring a manager ensures that firms in equilibrium produce more as a result of greater manager aggressiveness (while the owners' objective is to maximize profit, the objective of managers is to maximize revenues): the total quantity produced on the market increases but the profit reduces. The owners incentive managers to be more aggressive through the parameters $\alpha_1 < 1$ and $\alpha_2 < 1$. Instead in case of Bertrand competition if the innovator licenses with fixed fee, strategic delegation raises the probability of licensing its technology. In the case of Bertrand competition, the owners of the firms fix the parameters knowing that in the next stage of the game the managers will compete with the prices. They set $\alpha_1 < 1$ and $\alpha_2 < 1$ making sure that the managers don't behave in an aggressive way: they know that every growth in the price generates an increase in the price of the rival, so they motivate managers to behave in a less aggressive way through an overcompensation of profits. This leads to fix higher prices (lower quantities) than in the case of no strategic delegation with a growth both of the patent-holder's market profit and of the licensing profit F (in this setting, it is equal to market profit because in case of no licensing the rival isn't on the market).