Patent protection, threat of litigation and tacit collusion

Carlo Capuano [*] and Iacopo Grassi[†]

Abstract

In this paper, we propose an entry game that shows under which conditions owning a patent portfolio can be a non-pricing mechanism able to facilitate collusion. In our model, the incumbent fixes the level of patent protection and, given the threat of denunciation that reduces entrant's expected profits, entry may be profitable only when firms collude; moreover, if the entrant deviates from collusion, the incumbent can strengthen punishment suing her for patent infringement, reducing the entrant's unilateral incentive to deviate. Antitrust Authorities should pay attention to the level of patent protection implemented by the incumbent, and to her reaction to the entry of a competitor.

Keywords: patent, litigation, collusion, foreclosing, raising rivals costs.

JEL Code: D4, D43, K2, K21, L1, L13.

[*]Department of Economics and Statistics (DISES), University of Naples Federico II - Complesso Universitario di Monte S.Angelo, Via Cinthia, Naples, Italy - tel.+39081675021 - email: carlo.capuano@unina.it

[†]Department of Political Science, University of Naples Federico II - Via Rodino' 22, Naples, Italy - tel.+390812538229 - email: iagrassi@unina.it

1 Introduction

The scope of patents in economics has been debated for decades. On the one side there are those who, using a classical argument which dates back at least to Schumpeter (1942), have argued that firms will not have sufficient incentives to invest in research and development activities if they are not allowed to capture the value generated by their investments for some significant period of time.[1] On the other side there are those who argue that patent protection actually hurts innovation at a broader social level: patents are a barrier to entry that grants temporary monopolies and restrain the ability of other firms or individuals from making improvements and disseminating knowledge, and hence create disincentive for further research and development.[2]

Both the sides agree in considering patenting as a way to obtain temporary monopoly: in the limit case, firms are willing to purchase the patents of potential entrants to preserve their monopoly power.

However, several studies concerning different periods, countries and industries, argued that the classical explanation of patents presents some defects.[3] In the years, economic theory has shown that firms use patents for different purposes and that creating barriers to entry might not be the main one. Following Somaya (2012), it is possible classify three main patent strategies: proprietary (or offensive), defensive and leveraging strategy.

The offensive strategy is the classical one: a firm builds a fence of patents around her own business, to prevent imitation and to minimize the chance that the set of patents can be invented around and overturned, in order to obtain a monopolistic position in the market. Firms patent even to defensive purposes: owning patents allows to strengthen the position in trial and rebut a patent infringement sue. The defensive strategy may create a sort of arms race in some industries.[4] According to the leveraging strategy, patents are a valuable tool for generating additional rents, for example from patent licensing revenues, which may be issued in context far from the core business of the firm,[5] or may signal to the market the skills of a firm, attracting investors and increasing her

[1] Papers considering patent as a necessary evil to promote innovation and dissemination of new knowledge are Nordhaus (1969), Klemperer (1990), Gilbert and Shapiro (1990), Chesbrough (2003) and Lerner and Tirole (2004).

[2] On this argument see, inter alia, Boldrin and Levine (2008a, b) and Bessen and Maskin (2009).

[3] For a survey see Pénin (2008, 2012).

[4] See Hall and Ziedonis (2001).

[5] A borderline case is referred to the so called *'patent trolls'*, firms that do not commercialize products themselves, but extract rents from patent litigation. The analysis of trolls is beyond the scope of this paper.

value (Long, 2002; Shankerman, 2013).[6]

Most of the literature focuses on an incumbent protecting her market with patents: it is not surprising that patents can be used for creating strategic barriers to entry and that new competitors are discouraged to entry a market where an incumbent threatens patent litigations and costly lawsuits. In recent years there has been a huge increase in patents[7] and often patents were granted to goods and ideas that are not clearly new inventions:[8] from the design of smartphone, that led to the so-called smartphone war between Apple and Samsung, to the patent for one-click ordering technology, that led to a patent war between Amazon.com and Barnes & Noble.

When patents cover not-substantial or trivial aspects of the good or of the production, they may fail to protect the market and firms that own these patents may lose lawsuits involving their violation. This is the case of imperfect patent protection, the object of our analysis: we concentrate on patents that do not grant monopoly, but give a probability of succeeding in trial.

In our paper we propose an entry game in which the incumbent chooses the level of patent protection and analyze an argument that, to the best of our knowledge, has not been studied by the literature: the effect that patents and threat of litigation may have on the ability of the firms to collude.[9] If there is threat of denunciation, that reduces entrant expected profits, entry may be profitable only when firms collude; moreover, if the entrant deviates from collusion, the incumbent can strengthen punishment suing her for patent infringement, hence reducing the unilateral incentive to deviate of the entrant. In other words, firms may tend to increase patenting in order to relax competition on

[6] Somaya (2012) states: 'Among the many reasons for patenting described in prior work are blocking (defensive and offensive), preventing copying, building fences and thickets, earning licensing income, avoiding litigation by others, use in negotiation and exchange, motivating and rewarding'.

[7] Boldrin and Levine (2013) note that 'In 1983 in the United States, 59,715 patents were issued; by 2003, 189,597 patents were issued; and in 2010, 244,341 new patents were approved. In less than 30 years, the flow of patents more than quadrupled'.

[8] A recent branch of the literature studies the role that Patent and Trademark Offices (PTOs), which tend to certificate every application they receive, play in such a growth: the increasing number of patents is not due to investment in R&D, rather is caused by an inefficient mechanism of patenting. See, for example, Farrel and Shapiro (2008), Caillaud and Duchene (2009), Comino and Graziano (2015).

[9] To the best of our knowledge, there is a small literature on the relation between patents and collusion: Kultti et al. (2007) argue that patenting makes collusion more difficult, since the deviating firm is uncertain whether it will get the patent; the paper more related to this work is Grassi (2015), where the analysis focuses on the case of vertical differentiated oligopoly.

the market.[10]

It emerges that enforcing patent protection and threatening patent litigation can be used by the incumbent as a credible instrument for punishing any deviations from collusive schemes and implementing collective dominance solutions as part of a subgame perfect Nash equilibrium (SPNE) of the game. This means that enforcing patent protection can be part of a pro-collusive strategy by firms with significant market power abusing their dominant position, in violation of Article 102 of the Treaty of Functioning of the European Union (TFEU).[11]

The paper is organized as follows. In Section 2 we briefly recall the framework we use to analyze collusion sustainability; in Section 3 we present the model and analyze the SPNE of the game, focusing on the case where collusion emerges as equilibrium; competition policy implications and conclusions are demanded to Section 4.

2 Tacit collusion in oligopoly

Tacit collusion is a strategic conduct that enables firms to obtain supranormal profits, where normal profits correspond to the ones achieved in the one shot game equilibrium. The analysis of collusion in modern economics is based on the so called *incentive compatible constraint* for collusion: if firms follow *grim trigger strategy,*[12] then collusion is sustainable if there are not incentives to defect, which requires the expected benefits from collusion to be higher than the expected benefits from deviation.

In general, collusion is more likely to arise the lower the profit that a firm would obtain from deviation, the lower the expected profits she

[10] Our paper is somehow connected to the broad literature, theoretical and empirical, on pro-collusive versus anti-collusive effects of

joint R&D activities and joint ,patent.

For a theoretical analysis of joint R&D and collusion see, for example, Martin (1995) and Cabral (2000). But our analysis is positioned downstream of the process of R&D and focuses on single-firm patent used as instrument to endogenously increase competitors' expected costs.

[11] Recently literature on the strategic use of patents has analyzed abuses of single dominant position by the owner of a patent portfolio finalized to maintain a monopolistic position: Bennet (2002) and Rubinfeld and Maness (2005) focus on non-price predatory strategy by multi-licensing and tying-in contracts; analysis of deterrence to entry through the refuse of licensing or the threat of sue for patents infringement are in Lerner and Tirole (2004), Rubinfeld and Maness (2005), Robledo (2005), Agarwal et al.(2009) and Clarkson and Toh (2010).

[12] A grim trigger strategy is usually applied to repeated prisoner's dilemmas, in which a player begins by cooperating in the first period, and continues to cooperate until a single defection by her opponent, following which, the player defects forever playing Nash Reversion.

earns once the punishment starts, the more weight each firm attaches to the future profits. The latter depends on the value of the firm's discount factor of the future profits (usually indicated for firm i with the symbol δ_i).

Following Friedman (1971), let N, C and D be respectively the one-shot payoffs in the Nash equilibrium, in case of collusion and in case of deviation from collusion. Considering supergames, i.e. infinitely repeated one-shot games, when deviation is punished by Nash reversion, in order to sustain collusion the following incentive compatible constraint must be satisfied.

$$\frac{C}{1-\delta_i} \geq D + \frac{\delta_i N}{1-\delta_i} \tag{1}$$

That is

$$\delta_i \geq \sigma^* = \frac{D-C}{D-N} \tag{2}$$

where δ_i is the individual discount factor of firm i, that measures the weight of future profits, and σ^* is the critical discount factor. Constraint (1) compares expected profits by collusion with the ones by deviation in an infinite-horizon setting. According to (2), only if each firm is sufficiently patient, i.e. $\forall i$, $\delta_i \geq \sigma^*$, tacit collusion is part of a SPNE of the considered game.

The higher the value of σ^*, the more difficult the sustainability of collusion is.[13] This argument can be applied to every kind of oligopolistic market.

3 Incumbent versus Entrant

In this Section we analyze the incumbent's choice on registering patents in a pre-entry stage. She can play three different strategies: the first, that we call *non-cooperative (or non-collusive) strategy (nc)* assumes that the incumbent maximizes her non-collusive expected profits conscious of the potential entry of a new competitor; the second strategy, that we call *full deterrence (fd)*, requires a level of patent protection so high that entrant's expected profit is non positive; the third strategy is *accommodation of entry and collusion (ac)*. The emerging strategy depends on costs of implementing patents protection and of related lawsuits.

[13] For example it easy to show that, in a duopoly with linear demand and constant marginal costs, collusion is easier to sustain under price competition ($\sigma^* = 0.5$) than under quantity competition ($\sigma^* \simeq 0.53$).

3.1 Model setting

We consider a market where initially only one firm, the incumbent I, operates and tries to protect her monopoly by enforcing patent protection. She can register an arbitrary number of patents and endogenously enforce a wished level of patent protection. In particular we assume that the size of the patent portfolio is deterministically correlated with the endogenous probability of succeeding in a patent litigation. Indeed, we simplify our analysis assuming that the incumbent directly decides the level of patent protection and that implementing patent protection is costly, i.e. in order to enforce a probability of succeeding in a patent litigation equal to $\beta \in [0, 1]$, the incumbent bears a cost $x(\beta)$: it represents all the costs required for developing, registering and commercializing the new product.

The cost function is increasing and convex with respect to β, and such that the incumbent earns negative expected profits by enforcing a probability of success equal to one, even thought entry would be effectively deterred.[14] The incumbent tries to protect her market with a portfolio of patents and, if a competitor E enters the market, she can sue the entrant for patent infringement; a court decides whether the entrant is guilty or not. In case of lawsuit incumbent and entrant sustain a cost L regardless the outcome of the process and we assume that, under a legal patent protection system, none can be tried two times for the same violation.

If the incumbent wins the trial, a fine F is charged to the entrant and transferred to the incumbent and the entrant goes out from the market; conversely, if the decision is in favor of the entrant, no fine is charged and the entrant starts producing the new product without any additional restriction.

The following stages describe the timing of the game:

- At stage t=0, in a pre-entry stage, the incumbent chooses the number of patents to protect her invention. This implements an endogenous probability β of success in a lawsuit for patent rights infringement.

- At stage t=1, the entrant observes β and at decides whether to enter the market and imitate the monopolistic firm. If $\beta = 0$, at stage t=1 the competitor always enters the market and collusion is sustainable if firms are sufficiently patient. If $\beta > 0$ entry may be or not be foreclosed. In case the foreclosing strategy is effective, the incumbent produces the monopolistic output and this stage is infinitely repeated.

[14]We assume that $x(0) = 0$, $x' > 0, x'' > 0$ and $x(1) >> \frac{M}{1-\delta_I}$ where M and δ_I respectively stay for the one-shot monopolistic profit and the incumbent's discount factor.

- At stage t=2, in case of entry, the incumbent may sue the entrant for patents infringement. If the incumbent does not sue the rival, a duopolistic game starts and it is infinitely repeated. This scenario is coherent with the incumbent's collusive strategy.

- At stage t=3, if the incumbent has replied to the entry suing the rival (non-collusive strategy), a court (nature) decides whether patent infringement occurs or not, according to the level of β. If the entrant is declared guilty (with probability β), she pays a fine F to the incumbent, and exits the market; the incumbent produces the monopoly output. If the entrant is declared not guilty (with probability $1-\beta$), the two firms play an infinite repetition of the duopolistic game.[15]

Figure 1 illustrates the tree of the game.

In any stage firms play simultaneously and non cooperatively; when collusion occurs this is part of a SPNE of the game. We assume that all the stages of the constitutive game belong to the same unit of time and firms discounted profits starting from its first repetition.

3.2 Non-collusive entry (nc)

We start considering the non-collusive scenario. When entry occurs the incumbent sues entrant for patent infringement and, if the court declares the entrant not guilty, the two firms play the one-shot Nash equilibrium in the production stage. Otherwise, the entrant pays a fine and exits the market, while the incumbent remains monopolist in the production stage. Hence, firms' expected profits are the following:

$$\Pi_E^{nc} = \beta(-F) + (1-\beta)\left(\frac{N_E}{1-\delta_E}\right) - L \tag{3}$$

$$\Pi_I^{nc} = \beta\left(\frac{M}{1-\delta_I} + F\right) + (1-\beta)\left(\frac{N_I}{1-\delta_I}\right) - x(\beta) - L \tag{4}$$

where:

E and I respectively label the entrant's and the incumbent's parameters, control variables and objective functions;

Π_E and Π_I are respectively the entrant's and the incumbent's expected profits;

[15] Notice that after the court pronunciation in favor of the entrant we exclude firms can collude. This is not an assumption but it is an implicit result of our model setting. In fact, since lawsuit and patent registration costs are sunk at this moment of the game, collusive, deviation and Nash one-shot profits are the same we can compute before the pre-empty stage, i.e. the critical discount factors needed to collude at stage 3 is the same computed at stage 1. Then, if collusion was not sustainable at the beginning, it will not be at this stage of the game.

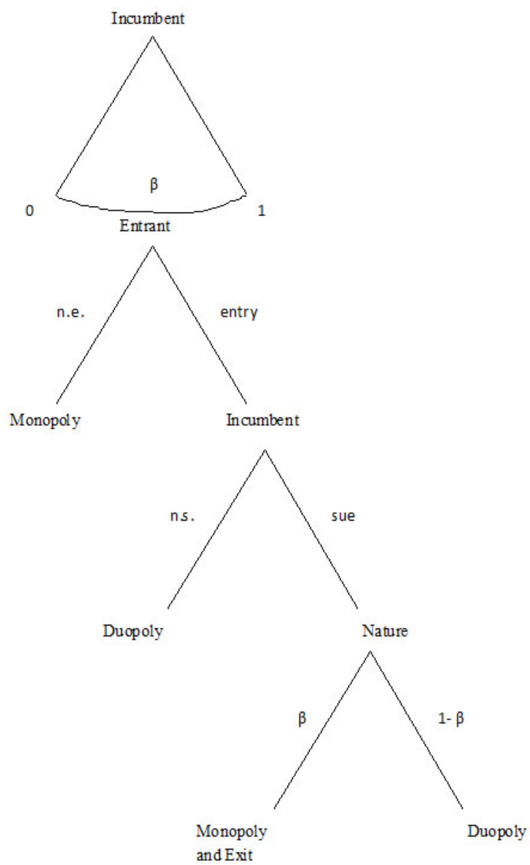

Figure 1: The tree of the game.

nc is the index that identifies the non-cooperative scenario;

$\beta \in [0,1]$ is the probability of succeeding in the lawsuit for the incumbent (i.e. the level of enforced patent protection);

$x(\beta)$ is the cost for implementing a level of patent protection equal to β;

L is the fixed cost for standing trial;

F is the fine charged to the entrant and transferred to the incumbent when the court determines a patent infringement;

M is the one-shot monopoly profit when only the incumbent produces;

N_E and N_I are the entrant's and the incumbent's one-shot Nash profits in duopoly when both firms produce;

δ_E and δ_I are respectively entrant's and incumbent's discount factors.

In order to have a framework as general as possible, we assume that $M > C_I \geq C_E > N_I \geq N_E \geq 0$, $\delta_E \in [0,1)$ and $\delta_I \in [0,1)$, all the relevant parameters are a common knowledge and the firms' discount factors are observable.

In this scenario the incumbent sets β equal to a level β^{nc} such that her expected profit is maximized, that is:

$$\beta^{nc} = \arg Max \Pi_I^{nc}(\beta)$$

Consider the profit expressed by condition (4), maximizing with respect to β we have:

$$\frac{M - N_I}{1 - \delta_I} + F = x'(\beta^{nc})$$

Notice that β^{nc} is unaffected by the cost of standing trial L, while is decreasing with respect the cost of implementing patent protection, $x(\beta)$ since the latter is assumed increasing in β.

3.3 Full deterrence (fd)

When we exclude any effective patent protection, i.e. $\beta = 0$, entry always occurs since the expected entrant profit, $\Pi_E^{nc}(\beta = 0)$, is strictly positive:

$$\Pi_E^{nc}(\beta = 0) = \frac{N_E}{1 - \delta_E} > 0$$

When $\beta = 1$, whenever $F + L \geq N_E$ we have $\Pi_E^{nc} \leq 0$ and entry is effectively deterred.

Conversely, for any $0 < \beta < 1$ there exist a threshold value of the level of patent protection β^{fd}, implemented by the incumbent, such that for higher values of β entry is not profitable without collusion, i.e. the entrant's expected profit computed in (3) is constrained to zero:

$$\beta^{fd} = \frac{N_E - L(1-\delta_E)}{N_E + F(1-\delta_E)} \tag{5}$$

Hence, setting $\beta \geq \beta^{fd}$ the full deterrence strategy is effective and the incumbent's expected profit is the following:[16]

$$\Pi_I^{fd} = \Pi_I^{nc}\left(\beta^{fd}\right) = \frac{M}{1-\delta_I} - x\left(\beta^{fd}\right) \tag{6}$$

Notice that β^{fd} is unaffected by the cost of implementing patent protection $x(\beta)$ but it is decreasing with respect to the level of cost of standing trial L.[17]

3.4 Accommodation and collusion (ac)

In the accommodating scenario the incumbent does not sue the entrant and firms start playing a duopoly. The collusive profits are the following:

$$\Pi_E^{ac} = \frac{C_E}{1-\delta_E} \tag{7}$$

$$\Pi_I^{ac} = \frac{C_I}{1-\delta_I} - x(\beta) \tag{8}$$

where

C_E and C_I are respectively the entrant's and the incumbent's one-shot profits in case of accommodation and collusion, while the apex ac identifies the collusive scenario.

In our framework this can appear in two different cases.

The first case of collusive accommodation occurs when firms are sufficiently patient to collude even though no patent protection is implemented at stage t=0. According to Friedman (1971), this occurs when

$$\delta_I \geq \sigma_I(\beta = 0) = \frac{D-C}{D-N_I} \tag{9}$$

$$\delta_E \geq \sigma_E(\beta = 0) = \frac{D-C}{D-N_E} \tag{10}$$

The second case occurs when either one or both the previous conditions are not satisfied at $\beta = 0$, and the incumbent implements a positive level of patent protection (i.e. $\beta > 0$).

[16] This conduct could be configured as a strategic barrier to entry.

[17] Note that if $\beta^N \geq \beta^F$, the full deterrence strategy dominates the non-collusive one and, excluding collusion, the incumbent sets $\beta = \beta^F$.

In this case firms play the following *modified grim trigger strategy*:

- When the new competitor enters the market the incumbent does not sue her for patent infringement and in the first production stage the two firms collude.

- In the following repetition any firm observes the behavior of the competitor in the previous stage: if both the firms played collusively, each firm continue to collude; if a deviation occurred, the cheated firm starts a Nash reversion as punishment. Furthermore the ex-incumbent, either as cheated or cheating firm, sues the rival for patent infringement.

The entrant's expected profit by deviation, Π_E^{Dev}, is the following.

$$\Pi_E^{Dev} = (D_E - L) + \beta(-F) + (1-\beta)\left(N_E\left(\frac{\delta_E}{1-\delta_E}\right)\right) \tag{11}$$

where parameter D_E stays for the entrant's one-shot deviation profit, while the index Dev identifies the deviation case. As usual, we assume that $D_E > C_E > N_E$ and $L, F < N_E$.

The entrant's incentive compatible constraint $\Pi_E^{Coll} \geq \Pi_E^{Dev}$, that makes collusion sustainable is the following:

$$\frac{C_E}{1-\delta_E} \geq (D_E - L) + \beta(-F) + \left(\delta_E\left(\frac{N_E(1-\beta)}{1-\delta_E}\right)\right) \tag{12}$$

From which,

$$\delta_E \geq \sigma_E(\beta) = \frac{(D_E - L) - F\beta - C_E}{(D_E - L) - N_E + \beta\,(N_E - F)} \tag{13}$$

There is a threshold value of the entrant's discount factor, $\sigma_E(\beta)$, that makes constrain (12) satisfied as an equality. Consequently, the collusive strategy is part of a SPNE only if the entrant's discount factor, δ_E, is not lower than this $\sigma_E(\beta)$.

It is easy to check that increasing either the level of patent protection, the legal cost of a trial or the fine for violation, i.e. increasing respectively β, L or F, unambiguously decreases the entrant's critical discount factor, $\sigma_E(\beta)$, making collusion easier to sustain.

In this model the incumbent is the only firm to have patents, that is the possibility to sue the competitor. For the incumbent, deviating from collusion means defecting the tacit agreement and suing the entrant for patent infringement, if the cost of a trial is lower than the associated expected benefit, i.e. if $L \leq \beta\left(F+\delta_I \frac{M-N_I}{1-\delta_I}\right)$.[18] Since we have assumed that fines are transferred to the incumbent the profit of deviation will be:

$$\Pi_I^{Dev}(\beta) = D_I + \beta\left(F + \delta_I \frac{M}{1-\delta_I}\right) + (1-\beta)\frac{\delta_I}{1-\delta_I}N_I - x(\beta) - L \quad (14)$$

where C_I and D_I are respectively the incumbent's one-shot collusion and deviation profits.

The incumbent's incentive compatible constrain, given by $\Pi_I^{Coll}(\beta) \geq \Pi_I^{Dev}(\beta)$, is now:

$$\frac{C_I}{1-\delta_I} \geq D_I - L + \beta\left(F + \delta_I \frac{M}{1-\delta_I}\right) + (1-\beta)\left(\frac{\delta_I}{1-\delta_I}N_I\right) \quad (15)$$

From which,

$$\delta_I > \sigma_I(\beta) = \frac{(D_I - L) - C + F\beta}{(D_I - L) - N_I - \beta\left(M - N_I - F\right)} \quad (16)$$

As for the entrant, there is a threshold value of the incumbent discount factor, $\sigma_I(\beta)$, that makes constrain (15) satisfied as an equality. Consequently, the collusive strategy is part of a SPNE only if the entrant's discount factor, δ_I, is not lower than this $\sigma_I(\beta)$.

Notice that, in this case increasing either the level of patent protection or the fine for violation, i.e. increasing respectively β or F, unambiguously increases the incumbent's critical discount factor, $\sigma_I(\beta)$, making collusion harder to sustain. Conversely, increasing the legal cost of a trial, L, decreases the incumbent's critical discount factor, σ_I, making collusion easier to sustain.

Figure 2 represents the incumbent's and the entrant's critical discount factors as functions of the level of patent protection enforced by the incumbent. For simplicity, we assume symmetry in the one-shot Nash profits, i.e. $N_E = N_I$. The horizontal dotted line that starts from the point A represents the critical discount factor when there is not patent protection ($\beta = 0$): in this case incumbent's and entrant's critical discount factors are equal. For positive level of patent protection the $\sigma_E(\beta)$ (continuous line in Figure 2) decreases, while the $\sigma_I(\beta)$ (dotted line) increases.

[18] Notice that when $L > \beta\left(F+\delta_I \frac{M-N_I}{1-\delta_I}\right)$, the incumbent does not denounce competitor and her expected profit by deviation becomes $D_I + \delta_I \frac{N_I}{1-\delta_I}$ as in the case in which $\beta = 0$.

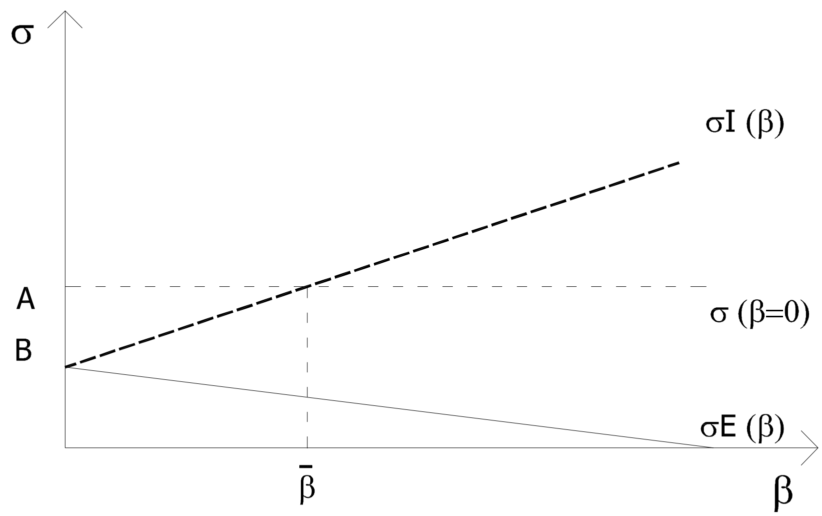

Figure 2: Critical discounts as functions of the level of enforced patent protection β.

The analysis of the graph allows us to state the following proposition:

Lemma 1 *If $\overline{\beta}$ is the positive level of patent protection such that $\sigma(0) = \sigma_I(\overline{\beta})$, then:*
- If $\beta < \overline{\beta}$, then $\sigma_E(0) > \sigma_E(\beta)$ and $\sigma_I(0) > \sigma_I(\beta)$;
- If $\beta > \overline{\beta}$, then $\sigma_E(0) > \sigma_E(\beta)$ but $\sigma_I(0) < \sigma_I(\beta)$.

Proof. A marginal increase in β has a negative and discrete impact equal to L on the expected gains by deviation of both the firms. This creates a discontinuity and a downward jump in the discount factors of both the firms (point B in Figure 2). Any additional increase in the level of patent protection has a different impact on entrant's and incumbent's deviation profits, and hence on the critical discount factors. In particular, until a threshold values $\overline{\beta}$, increasing β implements levels of critical discount factors lower than the ones computed in the case of no patent protection. According to Figure 2, for levels of β higher than $\overline{\beta}$, $\sigma_E(\beta)$ continues to decrease, while $\sigma_I(\beta)$ is higher than $\sigma_I(0)$. ■

The previous Lemma leads us to the following Proposition.

Proposition 2 *If $\beta < \overline{\beta}$, collusion is unambiguously easier to sustain, since the critical discount is lower for both the firms than the one computed in the no patent case, i.e. when $\beta = 0$; while if $\beta > \overline{\beta}$, the level of* *patent protection implemented may be interpreted as a signal of the willingness of a " patient" incumbent (a firm with a very high δ_i) to induce a "impatient" entrant to collude.*

Proof. The Proposition follows from Lemma 1. ■

In both the cases (i.e. $\beta < \overline{\beta}$ and $\beta > \overline{\beta}$) the level of patent protection is a strategic tool in the hands of the incumbent, which have effects on the attitude to collude.

3.5 Collusion sustainability

In our model each firm has an individual discount factor, respectively, δ_I and δ_E that measure their intertemporal preferences: the higher the individual discount factor the higher is the weight that firm gives to the future, i.e. the higher is her level of patience. In previous sections we computed the critical discount factors, $\sigma_I(\beta)$ and $\sigma_E(\beta)$ as function of the level of β implemented by the incumbent. In Figure 2, we drawn the critical discount factors of the incumbent and the entrant as function of β. Notice that when $\beta = 0$ and $\beta = 0^+$, $\sigma_I(\beta) = \sigma_E(\beta)$, while for $\beta > 0$, the incumbent's critical discount factor is increasing in β, as long as the entrant's one is decreasing.

Analyzing the graph we can obtain the necessary conditions for collusion sustainability:

Proposition 3 *If β_i^{ac} is the value of β such that $\sigma_i(\beta_i^{ac}) = \delta_i$ (where $i = I, E$), necessary conditions for collusion sustainability in the accommodating scenario are:*
(a) $\delta_I \geq \sigma_I(0^+)$;
(b) $\beta_E^{ac} \leq \beta_I^{ac}$.

Proof. (a) Collusion is sustainable as part of the SPNE of the game if and only if, for each firm, the individual discount factor is not lower than her critical one. Since $\sigma_I(\beta)$ is increasing in β and $\sigma_I(0^+)$, is the minimum value of the function $\sigma_I(\beta)$, if $\delta_I < \sigma_I(0^+)$, collusion cannot be sustainable by definition, hence we must have $\delta_I \geq \sigma_I(0^+)$. (b) Compare now the two firms discount factors, δ_I and δ_E. We have two possible cases, in both the relevant discount factor for collusion sustainability is the one of the impatient player. In the first case we concentrate on the incumbent (that fixes the β): if $\delta_I < \sigma_I(0^+)$ collusion cannot be sustainable; if $\delta_I \geq \sigma_I(0)$, we have two patient firms and collusion is sustainable at $\beta = 0$; if $\sigma_I(0^+) \leq \delta_I < \sigma_I(0)$ collusion is sustainable at $\beta = 0^+$. In the second case, i.e. when $\delta_I > \delta_E$, we concentrate on the impatient entrant. Analogously to the previous case, if $\delta_E \geq \sigma_E(0)$,

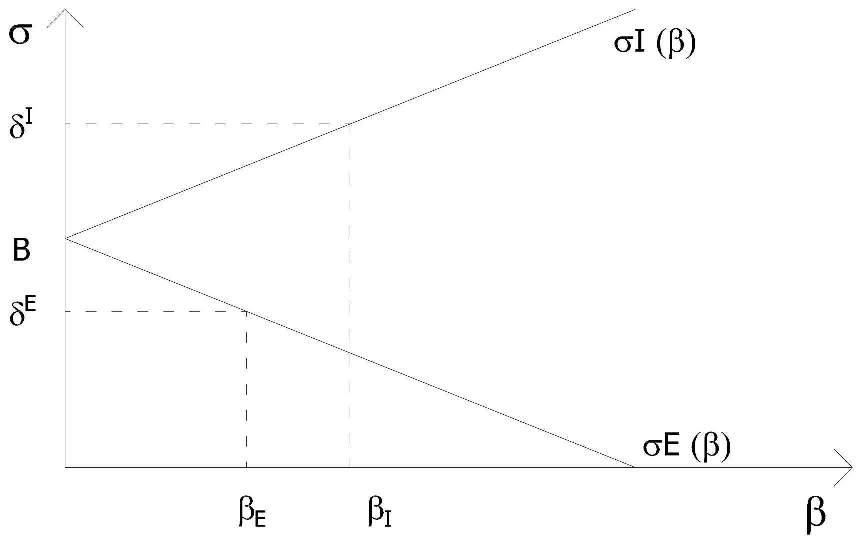

Figure 3: The case where collusion is sustainable as equilibrium with $\beta > 0$.

we have two patient firms and collusion may be sustainable at $\beta = 0$; if $\sigma_E(\beta = 0+) \leq \delta_E < \sigma_E(\beta = 0)$ collusion may be sustainable at $\beta = 0^+$. The case in which $\delta_E < \sigma_E(\beta = 0+)$ and $\delta_I > \sigma_I(\beta = 0+)$ is illustrated in Figure 3. Focus on the values β_I^A and β_E^{ac}, computed such that respectively $\sigma_I = \delta_I$ and $\sigma_E = \delta_E$; if $\beta_E^{ac} \leq \beta_I^{ac}$ collusion is sustainable and the incumbent implements a level of patent protection exactly equal to β_E^{ac}. ■

When we consider the complete game, collusion is part of the SPNE of the game if and only if it is sustainable in the accommodating scenario and preferred in terms of expected profits to the full deterrence strategy and the non collusive one. This results is summarized in the following Proposition:

Proposition 4 *Collusion is sustainable as part of a SPNE of the repeated game if and only if the incumbent implements the minimum $\beta = \beta_E^{ac}$, such that the firms incentive compatible constraints to collude (constraints (12) and (15)) are satisfied and collusion maximizes the incumbent's expected profit (constraint (18)).*

$$\beta_E^{ac} = \min \beta : \begin{cases} \delta_E \geq \sigma_E(\beta) \\ \delta_I \geq \sigma_I(\beta) \end{cases} \tag{17}$$

$$\Pi_I^{ac}(\beta^{ac}) \geq MAX\left[\Pi_I^{nc}(\beta^{nc}), \Pi_I^{fd}(\beta^{fd}), 0\right] \tag{18}$$

Proof. Since increasing β is expensive for the incumbent, she sets the minimum discount factor such that entrant's and incumbent's incentive compatible constraints to collude and incumbent's participation constraint are satisfied. ■

The following numerical simulation provides an example in which collusion emerges as equilibrium at a level of $\beta > 0$. In this case, which corresponds to the one illustrated in Figure 3, the positive level of patent protection implemented by the incumbent may be interpreted as a signal of the willingness of a more patient incumbent to induce a less patient entrant to collude.[19]

We assume that the inverse market demand function is linear and given by $P(q_I, q_E) = a - b(q_I + q_E)$, with $a > 0$, where P, q_I and q_E are respectively the market price, the incumbent's and the entrant's output levels, which compete à la Cournot. The cost functions are respectively $C_I(q_I) = cq_I$ and $C_E(q_E) = cq_E$ with $c > 0$. In order to simplify calculation, we set $a = b = 1$ and $c = 0$. In this case it easy to show that one-shot profits of monopoly, Cournot-Nash, collusion and deviation, are respectively $M = 1/4 = 0.25$, $N = 1/9 = 0.11$, $C = 1/8 = 0.125$ and $D = 9/64 = 0.14$. Moreover we set $F = N$, $L = N/10$ and $x(\beta) = \beta^2$ and we assume that the firms' discount factors are respectively equal to $\delta_I = 0.50$ and $\delta_E = 0.20$.

In this case without a system of patent protection collusion is not sustainable: it is easy to check that $\sigma_I(\beta = 0) = 0.529421 > \delta_I = 0.50$ and $\sigma_E(\beta = 0^+) = 0.24528 > \delta_E = 0.20$. Furthermore, we have $\beta_I(\sigma_I = 0.5) = 0.0375 > \beta_E(\sigma_E = 0.2) = 0.0075$.

According to our model the incumbent has three strategies: she can foreclose the entry setting $\beta^{fd} = 0.5111$, she can play non collusively setting $\beta^{nc} = 0.1389$ or she can accommodate and collude setting $\beta^{ac} = 0.0075$. It is easy to obtain that $\Pi_I^{ac} = 0.24999 > \Pi_I^{fd} = 0.23876 > \Pi_I^{nc} = 0.17274$: in this case collusion is sustainable and preferred with respect to the alternative strategies.

The general framework presented in this paragraphs can be extended to any kind of oligopolistic interaction. In fact, any hypothesis on product differentiation (horizontal or vertical), cost asymmetry, geographical distance between markets and so on, just affects the level of the one-shot

[19] Collusion sustainability and profitability depend on the firms' critical discount factors, on the cost associated to implement the patents and to stand trial, on the one-shot profits of collusion, monopoly, deviation and Nash. Hence more cases and numerical simulations can be provided.

profits (N_j, C_j, D_j with $j = I, E$, and M) but does not alter, for example, the formulas of the constraints (17) and (18) that characterize the collusive equilibrium.

4 Competition Policy and Conclusions

Economic literature has pointed out a number of structural elements that may affect the ability of firms to collude when implicit price fixing agreement should be self-enforcing: e.g., number of firms, capacity constraints, demand fluctuations, multi-market contacts, etc. Antitrust authorities may use these elements to identify sectors where deeper investigations are needed.

In this paper we have shown that, owning a patent portfolio, threat of patent litigation can be a non-pricing mechanism to create or maintain a dominant position in the market. Entry may be profitable only when firms collude and, in case of defection, incumbent can sue entrant for patent infringement; this reduces the entrant's critical discount factor, making collusion easier to sustain. We obtain some clear results: patenting a patient incumbent can induces collusion with impatient entrants avoiding an aggressive entry from speculative rivals; if the incumbent does not sue the entrant, despite possessing a patent portfolio, she is trying to collude.

Accommodating entry may be an anti-competitive behavior and it should be subject to thorough and profound investigations since, under the current European Union Competition Law, it may be classified as abuse of dominant position in violation of Article 102 of the Treaty on the Functioning of the European Union (TFEU).

Notice that, in our setting, enforcing patent protection can be either a strategic barriers to protect the market power of monopolistic incumbent or a strategic instrument to select entrant according to their collusive attitude.[20] Economic literature has broadly stressed the welfare implication of the first case but, as we know, has almost ignored the collusive implications characterizing the second one. Unfortunately, if some Schumpeterian dynamic efficiency can justify the tolerance by antitrust authorities of single dominant positions at least in the short term, in case of collusive accommodation there is no sort of welfare defense to justify collusion.

Summing up, in terms of antitrust, patent protection and patent litigation can be a way to enforce a collective dominance. Our model suggests that, in the entry accommodation context, the level of patent

[20] Collusion is an unilateral effect of the incumbent's conduct. The role of the potential entry is not strategic, almost passive, since she only reacts to the signals, i.e. the levels of patent protection, sent by the incumbent.

protection implemented by the incumbent matters in a pro-collusive way.

Further extensions of our analysis move in at least two different directions. The first is considering the symmetric case of firms in the markets with their own patent portfolio. The second deals with the case where the firms discount factors are hidden information.[21]

[21] In our model each process ends with a verdict, i.e. the entrant can be declared guilty or not. Empirical evidences in patent litigations show that most of the trials end with retreating the denunciation and a private agreement. We can explain this as a way to exchange information revealing, for example, their collusive attitude.

References

Agarwal, R., M. Ganco and R. Ziedonis: 2009, Reputations for Toughness in IP Enforcement: Effects on Knowledge Spillovers through Employee Mobility, Strategic Management Journal, 30(13): 1349-1374.

Benett, D.E.: 2002, The power of patents and their strategic use, The 2002 Law Journal, Business North Carolina.

Bessen, J. and Maskin, E.: 2009, Sequential innovation, patents, and imitation, RAND Journal of Economics 40 (4), 611–635.

Boldrin, M. and Levine, D. K.: 2008a, Against Intellectual Monopoly, Cambridge Books, Cambridge University Press.

Boldrin, M. and Levine, D. K.: 2008b, Perfectly competitive innovation, Journal of Monetary Economics 55 (3), 435–453.

Boldrin, M. and Levine, D. K.: 2013, The Case against Patents, Journal of Economic Perspectives, American Economic Association, vol. 27(1), pages 3-22, Winter.

Cabral, L.: 2000, R&D cooperation and product market competition, International Journal of Organization 18: 1033-1047.

Caillaud, B. and A. Duchêne: 2009, Patent Office in innovation policy: Nobody's perfect, PSE Working Papers n 2009-39.

Chesbrough, H. W.: 2003, Open innovation: the new imperative for creating and profiting from technology. Boston, MA: Harvard Business School Press.

Clarkson G., Toh P.K. 2010. 'Keep out' signs: the role of deterrence in the competition for resources. Strategic Management J., 31(11):1202-1225.

Cosimo, S. and C. Graziano, 2015, How many patents does it take to signal innovation quality?, International Journal of Industrial Organization, Volume 43, November 2015, Pages 66-79.

Farrel, J and C. Shapiro: 2008, How Strong Are Weak Patents?, American Economic Review 2008, 98:4, 1347–1369, http://www.aeaweb.org/articles.php? doi=10.1257/aer.98.4.1347

Friedman, J. W.: 1971, A non-cooperative equilibrium for supergames, Review of Economic Studies 38 (113), 1–12.

Gilbert, R. and C. Shapiro: 1990, Optimal patent length and breadth, RAND Journal of Economics, 21(1):106–12.

Grassi, I.: 2015, The Effect of Lawsuits for Patent and Copyright Violation on Cartel Sustainability in a Vertical Differentiated Oligopoly, presented at XXXII EALE (European Association of Law and Economics) congress 2015.

Hall, B.H. and R.F. Ziedonis: 2001, The Patent Paradox Revisited: An Empirical Study of Patenting in the Us Semiconductor Industry, 1979-95, RAND Journal of Economics Vol. 32, No. 1, Spring 2001 pp. 101–128.

Klemperer, P.: 1990, How broad should the scope of patent protection be?, RAND Journal of Economics, 21(1):113–30.

Kultti, K., Takalo, T. and Toikka, J.: 2007, Patents hinder collusion, Helsinky Center of Economic Research Discussion Paper No. 144.

Lerner, J. and J. Tirole: 2004, Efficient Patent Pools, American Economic Review, 94(3): 691-711.

Long, C.: 2002, Patent signals, The University of Chicago Law Review Vol. 69, No. 2, pp. 625–679.

Martin, S.: 1995, R&D joint ventures and tacit product market collusion, European Journal of Political Economy 11: 733-741.

Nordhaus, W. D.: 1969, An Economic Theory of Technological Change, American Economic Review, American Economic Association, vol. 59(2), pages 18-28, May.

Pénin, J.: 2008, Strategic use of patents. An overview, DIMETIC lecture, April 10th, 2008, available at http://dimetic.dime-eu.org/dimetic_files/Penin-Strategic-Use-of-patents.ppt .

Pénin, J.: 2012, Strategic uses of patents in markets for technology: A story of fabless firms, brokers and trolls, Journal of Economic Behavior & Organization, 2012, vol. 84, issue 2, pages 633-641.

Robledo, J.R.: 2005, Strategic patents and asymmetric litigation costs as entry deterrence instruments, Economics Bulletin.- AccessEcon, ISSN 1545-2921. - Vol. 15.2005, 2, p. 1-9.

Rubinfeld, D.L. and R. Maness: 2005, The Strategic Use of Patents: Implications for Antitrust in Antitrust, Patents and Copyright: E.U. and U.S. Perspectives 85, Francois Leveque and Howard Shelanski, eds., Northampton, Mass.: Edward Elgar Publishing.

Schankerman, M.: 2013, Introduction to Symposium on Patents, Entrepreneurship and Innovation, Journal of Industrial Economics Vol. LXI, No 3, pp. 471-480.

Schumpeter, J. A.: 1942, Capitalism, Socialism and Democracy, Unwin, London.

Somaya, D.: 2012, Patent strategy and management: An integrative review and research agenda, Journal of Management 38 (4), 1084–1114.