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A Note on Patents and Leniency

Abstract: The purpose of this note is to investigate the relationship between patents and market collusion. Specifically, by using game theory tools, it is shown that patents can act as a leniency mechanism, i.e., they can enable firms to leave a cartel without the risk of retaliation. However, the socially beneficial role of patents is limited because Bertrand competition itself breaks the collusion via the existence of a prisoner's dilemma between sufficiently myopic market rivals. In the prisoner's dilemma, two social tensions, fear and greed, make firms deviate from collusion. Patenting breaks the collusion, but at the social cost of a temporary patent monopoly in the product market.

Keywords: patents, leniency, collusion, prisoner's dilemma

JEL classification codes: K21, O34, P14

Szkic o patentach i łagodzeniu kar

Streszczenie: Celem niniejszego szkicu jest zbadanie zależności pomiędzy patentami a zmową rynkową. W szczególności, poprzez zastosowanie narzędzi teorii gier, pokazano, że patenty mogą funkcjonować jako mechanizm łagodzenia kar, tj. patenty umożliwiają przedsiębiorstwom opuszczenie kartelu bez ryzyka działań odwetowych ze strony rynkowych rywali. Społecznie korzystna rola patentów jest jednak ograniczona, ponieważ sama konkurencja w rozumieniu Bertranda rozbija zmowę rynkową poprzez istnienie dylematu więźnia pomiędzy krótkowzrocznymi rywalami. W tym dylemacie dwa napięcia społeczne,

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strach i chciwość, sprawiają, że przedsiębiorstwa odstępują od rynkowej zmowy. Paten-
towanie także rozbija zmowę, ale społecznym kosztem powstania czasowego monopolu
na rynku produktu spowodowanego ochroną patentową.

Introduction

Intellectual property rights and market structures play a key role in the
development of knowledge sub-systems in a globalised world [Amable, 2003;
Kearney, 2009]. Knowledge sub-systems are the institutional architectures
that encompass innovation, research and development (R&D), and educa-
tion [Kearney, 2009]. The institutions which create an effective knowledge
sub-system offer a variety of microeconomic incentives to produce and dis-
seminate knowledge. Modern innovation policies use in particular two instru-
ments which encourage knowledge production and dissemination, i.e. cartels
in R&D, and patents [Chattopadhyay, Chatterjee, 2019].

A cartel is, in general, a group of firms that have agreed explicitly to coordi-
nate their activities in order to raise the market price, make rigged bids, limit
production output or divide markets [Pepall et al., 1999; Whelan, 2013; Kar-
bowski, 2015; Hellwig, Hüschelrath, 2017]. It is widely accepted that cartels
create losses in consumer surplus and total welfare [Whelan, 2013; Hellwig,
Hüschelrath, 2017]. An exception is R&D cartels [d'Aspremont, Jacquemin,
1988; Kamien et al., 1992; Kamien, Zang, 2000; Amir et al., 2011ab; Burr
et al., 2013], which usually enhance welfare by promoting innovation com-
pared with R&D competition. Under an R&D cartel, firms coordinate their
R&D investments in order to maximise a joint profit, but the firms remain
competitors in the product market and take decisions on the product price
or output unilaterally [Kamien et al., 1992].

D'Aspremont and Jacquemin [1988] showed that firms' R&D investments
are higher under an R&D cartel than R&D competition (the latter means uni-
lateral decisions on both R&D investments and products) if the level of techno-
logical spillovers in the industry is high enough. Kamien, Muller, Zang [1992]
and Kamien, Zang [2000] arrived at the same result, but in a general set-up
(N firms considered). The research showing that R&D cartels promote inno-
vation gave rise to public policy and competition law open to collaborative
R&D agreements [Cassiman, 2000; Barajas et al., 2012; Belderbos et al., 2018;
Bustinza et al., 2019]. For example, in Europe, competition policy started to dif-
ferentiate collaborative agreements that reduce competition from collabora-
tive agreements that promote innovation and competitiveness, and introduced
the block exemption of R&D–Commission Regulation (EC) No. 2659/2000):

"Since cooperation in R&D helps promote the exchange of know-how and technologies, to facilitate technical and economic progress, and to rationalize the manufacture and use of products that benefit consumers, this regulation exempts not only agreements the primary object of which is R&D, but also all agreements directly related to and necessary for the implementation of cooperation in R&D, provided that the combined market share of the parties does not exceed 25% of the relevant market".

In the United States, the government stimulates the formation of collaborative R&D agreements by providing more lenient antitrust rules [Marinucci, 2012]. The American legal acts (e.g., National Cooperative Research Act) state that firms willing to collaborate in R&D are evaluated by antitrust authorities under the rule of reason rather than the *per se* rule [Marinucci, 2012].

Leaving aside R&D cartels, cartel activity is prohibited. In European law, cartels are prohibited by Article 101(1) of the Treaty on the Functioning of the European Union [Whelan, 2013; Hellwig, Hüschelrath, 2017]. From 1999 to 2017, a total of 114 cartels (consisting of 615 firms) were convicted by the European Commission for cartelisation [Hellwig, Hüschelrath, 2017]. Average cartel duration has decreased substantially in recent decades. In the 1970s, average cartel duration was over 150 months. By the 1990s, that figure had decreased to about 50 months, followed by a further decline to about 10 months after 2010 [Hellwig, Hüschelrath, 2017]. The main reason was increasingly effective leniency programmes [Karbowski, 2015]. Other causes (such as firms' strategic entries and exits) are discussed by researchers including Suslow [2005], De [2010], Zhou [2012], Hellwig, Hüschelrath [2017].

Patents, in turn, seem to naturally limit competition by awarding a temporary monopoly on producing, using or selling the invention. In exchange for the temporary monopoly, patents are believed to promote inventions and help knowledge dissemination [cf., e.g., Mazzoleni, Nelson, 1998]. However, Kultti and colleagues [2006; 2007] question the belief that patents can only limit competition. In fact, the authors hypothesise that patents can effectively break market collusion. The mechanism behind that hypothesis is the acting of patents as private leniency, making firms immune to retaliation on the part of rivals, and thus, making them free to leave cartels. We set out to test this hypothesis under Bertrand price competition.

The purpose of this note is to investigate the relationship between market collusion and patents in Bertrand duopoly. Specifically, we show that, for Bertrand competition, the socially beneficial role of patents is limited. Bertrand competition itself breaks collusion via the existence of a prisoner's dilemma between market rivals. Fear and greed present in the prisoner's dilemma make firms deviate from collusion. Patenting also breaks collusion and makes the patentee immune to retaliation on the part of a rival, but at the social cost of a temporary patent monopoly.

With this note, we contribute to the growing body of literature on symmetric games and their applications [cf., e.g., Farahani, Sheikhmohammady, 2014; Płatkowski, 2017; Rusch, 2019]. In general, the game is symmetric if the set of strategies is the same for each player and the players' payoffs do not change by displacing their strategies [Farahani, Sheikhmohammady, 2014]. Prominent examples of symmetric games are the prisoner's dilemma, chicken game and the trust dilemma (assurance or stag hunt game) [cf., Farahani, Sheikhmohammady, 2014; Płatkowski, 2017]. Some authors have already identified a prisoner's dilemma in firms' process R&D under quantity competition [Amir et al., 2011ab; Burr et al., 2013]. The prisoner's dilemma explains why firms refrain from process R&D investments. Amir and colleagues [2011b] suggest that the prisoner's dilemma underlies the formation of an R&D-avoiding cartel. Its members are better off when they do not innovate and refrain from process R&D investments. We, in turn, identify a prisoner's dilemma in firms' product R&D under price competition. This kind of dilemma makes firms deviate from market collusion.

This note proceeds as follows. The next section focuses on leniency programmes and draws a parallel between patents and the leniency mechanism. Further, a symmetric Bertrand toy game with two enterprises as players is presented. Based on the game, we show that patents can enable firms to leave a cartel without the risk of retaliation, but the effect of cartel break can also be achieved without patents and the ensuing social cost of a temporary monopoly.

The links between patents and leniency – literature review

Leniency describes a system of partial or total exoneration from the penalties that would otherwise be applicable to a cartel member in return for reporting cartel membership and supplying information on the cartel to competition authorities [Charistos, 2018]. Wils [2016] observes that leniency programmes effectively reduce the time and cost of collecting cartel-related evidence, while also undermining trust among cartel members and leading to higher cartel detection and prosecution [Harrington, 2008; Karbowski, 2015; Charistos, 2018]. The rationale behind leniency is to structure the law so that economic agents involved in illegal actions find themselves in a situation close to a prisoner's dilemma. A cartel member may reduce sanctions when he/she unilaterally confesses to his/her illegal actions, making it possible to prove his/her former cartel partners guilty [Spagnolo, 2000]. Leniency reduces law enforcement costs for individual crimes [Kaplow, Shavell, 1994], has deterrence effects on illegal business relationships [Motta, Polo, 2003], and increases the incentives to report cartel membership [Spagnolo, 2004; Buccirossi, Spagnolo, 2005].

As regards the possible side effects of leniency programmes, Buccirossi and Spagnolo [2005] claim that leniency might provide a mechanism for occasional sequential illegal transactions (e.g., a corrupt deal between a manager

and auditor), which would not be feasible in the absence of leniency. Parties to an illegal transaction may collect evidence on the deal and use it as a lever, threatening to report the transaction to authorities in case of someone's deviation from the illegal contract [Buccirossi, Spagnolo, 2005]. A leniency programme makes such a threat credible, and, as a result, all parties comply with the illegal exchange, which would not be possible in the absence of leniency [Buccirossi, Spagnolo, 2005].

Interestingly, Kultti and colleagues [2007] observe that leniency programmes can be effectively replaced by patents. According to the researchers, patenting a yet unpatented invention constitutes the best strategy to deviate from collusion. A patent generates a stream of supernormal profits by granting the holder a monopoly position and protecting them against retaliation by former collaborators in a cartel. Essentially, a patent works like a leniency policy, making a former cartel member immune to potential retaliation or punishment [Kultti et al., 2007]. Such a patenting motive – to leave a cartel – belongs to non-standard functions of patents.

The standard functions of patents boil down to the following: patents promote inventions; patents help knowledge dissemination; patents limit wasteful invention efforts; and patents help technology transfer [cf., Boldrin, Levine, 2013; Karbowski, 2017]. Standard functions of patents serve productive entrepreneurship [Baumol, 1996], which is oriented at promoting public welfare. Non-standard functions of patents, in general, hardly facilitate productive entrepreneurship, and often only serve rent-seeking. On the basis of an extensive literature review [cf., e.g., Langinier, 2005; Penin, 2005; 2012; Blind et al., 2006; 2009; Chien, 2008; Noel, Schankerman, 2013; Grossmann et al., 2016; Förster, 2017; Holgersson, Granstrand, 2017], the following non-standard functions of patents can be distinguished: to block rivals, to use patents to increase someone's bargaining power in negotiations with potential business partners, to exploit a competitive advantage over rivals, to protect an enterprise's share in the domestic or international market, to increase the operating costs of the enterprise's rivals, to raise barriers to market entry, to mislead the enterprise's rivals in the patent race, and to force other enterprises to bear the expenses of a legal dispute over patent violation (patent predation strategy).

The relationship between collusion (or cartels) and patents is interesting not only from an economic but also legal and ethical viewpoints. Whelan [2013] claims that cartel activity is immoral because it can be conceptualised as stealing, cheating and deception [cf., Karbowski, 2015; Whelan, 2013]. Cartel activity fulfils all the conditions provided by the definition of stealing, which is an intentional violation of another's rights of ownership in something that is capable of being bought or sold [cf., Whelan, 2013]. Cheating means violating a fair rule with the intent to obtain an advantage over a party with whom the violator is in a cooperative and rule-bound relationship [Whelan, 2013]. Cartel activity can be interpreted as a form of cheating [Whelan, 2013; Karbowski, 2015]. Lastly, cartel activity can be interpreted as a deception, which

is a communicated message with an intent to cause a person to believe something that is not true [cf., Whelan, 2013].

Interestingly, patents can be interpreted as at least a case of quasi-deception, i.e. as a communicated message intended to cause a person to believe something that is not true but is perceived to be true by the message producer. Hence all arguments that aim to justify patents (including the natural rights' argument, the distributive justice argument, and consequentialist arguments) can be easily contested and are misleading [cf., Sterckx, 2006; Boldrin, Levine, 2013; Karbowski, 2017]. Roughly speaking, the relationship between cartels and patents seems legally and ethically interesting because patents can effectively limit collusion and break cartel agreements, leading to the replacement of one, stronger, form of deception (cartels) by another, weaker, form of deception (patents). Using a reference to Gresham's law [Giffen, 1891], we can say that "the weaker form of deception drives out the stronger form of deception".

Method

In this note, we use non-cooperative game theory tools to analyse the symmetric social dilemma (prisoner's dilemma), which occurs between Bertrand duopolists trading in a product invention that can be patented. We also use mathematical definitions of fear and greed, two basic social tensions [Płatkowski, 2017], discovered in the proposed Bertrand game.

Patents and leniency in the symmetric toy game – results and discussion

The leniency role of patents can be illustrated by the following symmetric toy game. Consider an industry composed of two symmetric firms competing in Bertrand fashion [Kultti et al., 2006]. Barriers to entry are sufficiently high (no entry occurs). Manufacturing costs are normalised to zero. The firms have come up with the same product invention that is subject to trade.

Initially, we consider a case when the invention is not protected by a patent. If the enterprises formed a cartel, they share the monopoly profits equally ($\frac{\pi_c^m}{2}$). If one firm deviates from collusion and undercuts the competitor, the deviator earns a monopoly profit, $\pi_d^m < \pi_c^m$, because the market price changed, and the rival gets zero. If both enterprises deviate, the payoffs are $\frac{\pi_d^m}{2}$ for both firms (we consider a symmetric game). The Bertrand game can be presented in the following strategic form (Table 1).

Table 1. The symmetric Bertrand duopoly game in a strategic form

	C	D
C	$\frac{\pi_c^m}{2}$; $\frac{\pi_c^m}{2}$	0; π_d^m
D	π_d^m; 0	$\frac{\pi_d^m}{2}$; $\frac{\pi_d^m}{2}$

Source: own elaboration.

Let us now extend our simple Bertrand duopoly game by allowing a third strategy, i.e., to file a patent application (strategy P). A patent ensures its holder exclusive rights to the invention and thereby a monopoly profit. Let $\pi_p^m = \pi_c^m$ denote the monopoly profit earned by the patentee (the competitor is not undercut, but excluded from trade due to patent protection). For simplicity, let us assume that the row player is the winner of the patent race and that he/she gains a patent (and the monopoly) for a traded product. The Bertrand game in a strategic form, including the patenting strategy, is then as follows (Table 2):

Table 2. The extended Bertrand duopoly game in a strategic form

	C	D	P
C	$\frac{\pi_c^m}{2}$; $\frac{\pi_c^m}{2}$	0; π_d^m	0; π_p^m
D	π_d^m; 0	$\frac{\pi_d^m}{2}$; $\frac{\pi_d^m}{2}$	0; π_p^m
P	π_p^m; 0	π_p^m; 0	π_p^m; 0

Source: own elaboration.

Let us now find the pure strategy Nash equilibria of the above games. Starting with Table 1, each of the firms can either collude (strategy C) or deviate from collusion (strategy D). The final payoffs depend on the decisions taken by the Bertrand duopolists. Observe that under Bertrand competition [cf., e.g., Anderson and Renault, 1999; Kultti *et al.*, 2006], $\frac{\pi_c^m}{2} < \pi_d^m$, $0 < \frac{\pi_d^m}{2}$, and $\frac{\pi_d^m}{2} < \frac{\pi_c^m}{2}$ (or simply, $\pi_d^m < \pi_c^m$). Knowing the above, the game presented in Table 1 exhibits only one Nash equilibrium in pure strategies, i.e. (DD) – bilateral deviation.

It is worth observing that the strategic game given in Table 1 constitutes a symmetric prisoner's dilemma. To prove this, let us use axioms derived from

Płatkowski [2017]. Since the game presented in Table 1 is symmetric, we can simplify the strategic form of the game to the following (Table 3):

Table 3. The simplified Bertrand duopoly game in a strategic form

	C	D
C	$\dfrac{\pi_c^m}{2}$	0
D	π_d^m	$\dfrac{\pi_d^m}{2}$

Source: own elaboration.

Now, let $\dfrac{\pi_c^m}{2}$ equal R (reward), π_d^m equal T (temptation), $\dfrac{\pi_d^m}{2}$ equal P (punishment), and 0 equal S (sucker). Following the axioms discussed by Płatkowski [2017], the prisoner's dilemma is defined by T > R > P > S. Note that this condition holds in our Bertrand duopoly game.

Furthermore, the various economic games can be characterised by different types of social tension between players, in particular fear and greed, two distinct motives underlying non-cooperative behaviour. The prisoner's dilemma is a social dilemma in which both fear and greed are present. Fear is present in the N-players' game if defection (or deviation) is a safer choice. Formally:

$$\exists n \in \{1,2,\ldots,N-1\} : P_d(n-1) > P_c(n), \text{ where}$$

$P_c(n)$ is the payoff for an individual who plays strategy C (cooperation or collusion), $P_d(n)$ is the payoff for a player who plays strategy D (defection or deviation), and n denotes the number of players who play C. For the two-player game, fear exists if for the cooperating player $P_d(0) > P_c(1)$, where $P_c(1)$ is the payoff for a player who plays strategy C if only he/she uses this strategy, and $P_d(0)$ is the payoff for a player who defects (chooses strategy D) if no one cooperates. One may check that fear is present in our simplified Bertrand game.

Greed, in turn, is defined as follows:

$$P_c(N) < P_d(N-1),$$

that is, greed is present in a game if in the group of N C-players, a C-player would be better off by changing to D. For the two-player game, greed exists if for the cooperating player $P_c(2) < P_d(1)$, where $P_c(2)$ is the payoff for a player who plays strategy C if the opponent cooperates, and $P_d(1)$ is the payoff for a player who defects if the opponent cooperates. One may check that the above condition holds in our Bertrand game (Table 3). Simply put, a player can exploit the colluder by turning to a deviation strategy.

Both fear and greed constitute incentives to play strategy D instead of strategy C. As a result, in our Bertrand game (Table 1), fear and greed make firms break the cartel and deviate from collusion. The rational and self-interested players, facing such a structure of incentives, follow strategies D, ending up in an equilibrium that is not Pareto optimal (CC is).

Now, analyse the game with patenting possibilities. The game given in Table 2 exhibits three Nash equilibria in pure strategies, i.e., (PC), (PD) and (PP) – unilateral or bilateral applying for a patent. All those equilibria result in breaking the cartel and granting the row player the exclusive rights to the product invention. Such a case, in contrast to playing strategy D, does not entail the risk of retaliation on the part of a product market rival since he/she, once the patent is awarded, can only licence it from the row player. Patents thus change the Bertrand game outcome, but at the social cost of a temporary monopoly.

It is also worth observing that in the context of the repeated game, unlike the case without patents (Table 1), coming back to the cooperation (or collusion) is not mutually beneficial in the extended Bertrand duopoly game (Table 2). The row player prefers (PC) to (CC) in the extended game (Table 2). Thus, the possibility of patenting significantly lowers the incentives to cooperate (collude), also in the dynamic context.

Further, in the repeated game without patents, the rational and self-interested players can collude if they are far-sighted enough. This means that fear and greed do not have to be sufficient protection against collusion in the dynamic context. Therefore, patent protection can play an important role in breaking the collusion between players who are far-sighted enough. This is a dynamic advantage of patents over Bertrand competition without patent protection.

Conclusions

According to some authors [cf., e.g., Chowdhury, 2005; Che, Yang, 2009], patents do not necessarily promote innovation due to so-called tournament effects: the existence of patent protection reduces the firms' R&D investments compared with competition without patents. This note also links patents with market competition. Our theoretical analysis shows that patents can break market collusion. The mechanism behind this relationship is that patents serve as private leniency, making firms immune to retaliation on the part of rivals and giving them freedom to leave cartels. However, for sufficiently myopic players, the effect of a cartel break can also be achieved without patents (Bertrand competition without patent protection) and the related social cost of a temporary monopoly. Two fundamental social forces, fear and greed, present in the Bertrand game without patents, make firms deviate from collusion and break the cartel.

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