The Development of Property Rights for Intellectual Property

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Abstract: This article analyzes the development of property rights (PR) for intellectual property (IP). There is a fundamental tension between competition policy and IP. IP rights confer a certain degree of monopoly power on the owner of IP rights. Some authors found that there are too many patents in Biotechnological or Internet industry. The regulation of intellectual property has expanded dramatically in many countries in recent years and competition authorities are increasingly asking for methodological help in determining the duration and scope of patents. The issue has taken on an increased importance and visibility in the wake of the numerous high profile court cases in the pharmaceutical and internet industry. This paper analyzes a model of PR development for IP. We consider an environment where two agents (researchers) decide whether to determine the allocation of PR or work without establishment of property rights. Both agents may be involved both in research and "political" fight for intellectual property. PR can improve the incentive of one party and worsen the incentive of another party. The main results are: 1) PR do not always emerge and; 2) their emergence is more probable when the more productive party has poor political skills.

Key Words: *Property Rights, intellectual property, Political Skills, Internet Industry*

1. Introduction

This article analyzes the development of property rights (PR) for intellectual property (IP). This is an important topic of research for a number of reasons. First, the regulation of IP has expanded dramatically in many countries in recent years (Kahin, 2002) and competition authorities are increasingly asking for methodological help in determining the duration and scope of patents (Gangi, 1999). Secondly, there is a fundamental tension between competition and IP. Competition policy is concerned with improving social welfare by limiting market power. IP rights on the other hand provide a certain degree of monopoly power on the owner of IP rights. For example, some authors found that there are too many patents in Biotechnological or Internet industry (Heller and Eisenberg, 1998, Heller, 2008). Third, the issue has taken on an increased importance and visibility in the wake of the numerous high profile court cases, especially because of certain merger proposals in Pharmaceutical and Internet industry. For example, Gilbert and Tom (2001) note how the number of mergers challenged, because of possible adverse effects on innovation, by the US Department of Justice and the Federal Trade Commission rose from only 4 in the 1990-1994 period to 47 in the 1995 to 1999 period. In September 2009, the antitrust agencies announced the possibility of updating the Merger Guidelines (Sidak and Teece, 2009). Innovation issues also featured prominently in several recent non-merger cases brought by these two US agencies.

Finally and this is the focus of present research, IP is distinct from other kinds of property in that here PR often do not exist and often because researchers and firms do not have incentive to establish PR. For example, a researcher who found some intermediate results may not necessarily try to get formal PR for these results (patent, research article etc.) before obtaining final or at least more important results. One line of explanation for this phenomenon is related to costly establishment and costly enforcement of PR. Since the law defining PR for IP is not very well developed and there is not enough specialists in this area etc., firms and individuals often avoid formal establishment of PR. Some literature investigates whether improvement of the law contributes to production efficiencies. The evidence is very ambiguous. Some authors find that improving laws and respectively reducing the cost of property rights enforcement contributes significantly to increasing productivity in research. However, more often in the literature there is a lack of confirmation of that idea (see, for example, Loshin, 2007). In this paper we develop an alternative view of possible absence of PR on IP based totally on economic incentives. We argue that in some cases PR will optimally not be established, even

if the laws are well developed and enforcement costs are negligibly small.¹ We borrow two ideas from existing literature. First, PR affect the incentives of agents involved in the production process. This is the property rights approach (Grossman and Hart, 1986, Hart and Moore, 1990, Aghion and Tirole, 1994 & Hart, 1995), where the relationships between parties involved in investment and production is driven by incomplete contracts. This is especially suitable for analyzing the process of research when the results are difficult to describe ex-ante. PR may increase the incentive to invest efficiently by allocating the residual rights of control. Secondly, the development of PR is often not only driven by differences in productive skills of parties but by their fighting (lobbying capacities, political power, military power, etc.) skills (Grossman and Kim, 1996, Grossman, 2001, Muthoo, 2004, Skaperdas, 1992, Skaperdas and Syropoulos, 1997). The agents' power is not necessarily correlated with their productive skills.

In our model two agents (research firms or researchers) decide how to design their relationship in order to increase the potential surplus from the production of a good. The good can be produced using a single existing discovery (idea, technology etc., further called IP). As an example, a good can represent a new kind of energy resource like solar energy, and the idea is to use some special material called X in some special conditions called Y . Initially there are no formal PR for this IP. For example, one can assume that both agents have participated in working on this idea and it is very difficult to establish the real owner of IP. Before the parties begin the actual production of the good, they need to make investments. For instance, one can think that researchers are specialists in slightly different areas (in the example above one specializes in energy, the second specializes in chemistry). Both kinds of knowledge are necessary to produce the good. But the parties still need to improve their skills before beginning the production (investment in human capital). As in the property rights approach, the good is too difficult to describe in advance and thus it is impossible to write a complete contract describing the production process and the allocation of the surplus in any state of nature. Hence, the only possible contract the parties can write is to determine the PR for IP (as in property rights approach). However, in contrast to the traditional property rights approach, the parties may decide not to allocate PR. The parties can still make investments in their skills development even if no one has formal PR on IP. If PR are not established and if there is a disagreement in the future, the conflict can only be resolved by a fight ("patent race") where the winner obtains the PR on IP and the loser receives nothing. The fight is for example, the court where each researcher will try to prove that he is the real owner of initial IP. The parties have different productive and fighting skills. Fighting skills can consist of political power of researchers, abilities to convince people, number of friends etc.

The main results we obtain are as follows. First, PR are not always established. To see this, recall the mechanics of the property rights approach. The initial levels of effort (investments) depend on future renegotiations concerning the division of the surplus from cooperation. The ownership of the IP affects the renegotiation outcome because it determines the residual control rights. The party who owns the IP typically provides a higher effort because it expects a higher surplus in the renegotiation. When PR are not established initially, renegotiations related to the surplus will be based on the results of a potential fight for the IP. If we compare this situation with one where one party has the PR, then, intuitively, the incentive of this party will be reduced because it will not necessarily win the fight (if its fighting skills are not very strong). On the other hand, the incentive of the party who did not own the IP can improve because there is a possibility of winning the fight and owning the IP (improving its position in renegotiations). We show that under some conditions the parties are better off establishing PR and allocating this right to one party (typically the more productive) and under other conditions the scenario without PR is better.

Second, we show that the emergence of PR is more probable if the fighting skills of the more productive agent decrease and less probable when the fighting skills of the more productive agent increase. Intuitively, in the former case, a fight is expected to be very costly because it may destroy the incentives of the more productive party. On the other hand, the latter situation does not destroy the more productive agent's incentives (because that agent is a skilful fighter), but may increase the incentives of the weak party at the same time. The formation of PR is more probable if the productive skills of the more productive party increase and less probable when the productive skills of the less productive party increase. Intuitively, in the former case,

¹For an additional discussion of different cost and benefits of IP see, among others, Watt (2006).

allocating PR to the more productive party, which became even more productive, ensures that party will continue to provide a high effort which leads to an increase in the size of the total surplus. One application of these results is that the strongest economic agents are not always interested in establishing PR, even if they enforceable at no cost.²

The latter result is similar to one obtained in Muthoo (2004). The author shows that the heterogeneity of agents' productive and fighting skills will affect the nature of PR (secure versus insecure). The focus of that paper is on the rights of the agents to the fruits of their own labour effort, in a setting where there is no opportunity for cooperation in the production process. In the secure PR situation, no agents will fight in a dynamic equilibrium. It is shown that when the more productive agent becomes more skilled at fighting, secure PR are more likely to emerge. In the present paper, agents do have the choice to produce jointly, and the absence of fighting is not a sufficient condition for PR to emerge. We distinguish between two "non-fighting" situations: one where PR exist and another without the establishment of PR. In Muthoo (2004), the absence of fighting has a natural interpretation in terms of PR: everybody will consume the results of their own labour. In our case, the focus is on the effect that PR on the means of production (ideas, discoveries etc.) have on incentives to provide effort in joint production. Agents can cooperate in production process and use IPs which do not have clear PR.

Other existing literature on PR typically emphasizes one of the above ideas: traditional property rights approach or fighting for PR complete contracts. In the first case it is assumed that the only possible way for the parties cooperate is to write a contract (enforceable without cost) that will assign PR. A situation where PR are not determined by such a contract and where property rights emerge as a result of conflict ("fighting") is not considered. In the second case agents are usually involved in both production and fighting activities. The latter are used to redistribute PR. An efficient equilibrium would be one where PR are allocated peacefully and no one fights. However, it may not be achievable since, for some agents with good fighting abilities, there is always an opportunity to redistribute property at a low cost. This set-up can be used, for instance, to analyze how agents allocate resources between fighting and productive activities. It can also be used (similar to Muthoo, 2004) to analyze "more secure" versus "less secure" PR. More secure PR are those where relatively more resources are allocated to productive activities, and less secure PR are those where relatively more resources are allocated to fighting (Grossman and Kim (1996), Grossman (2001)). There is also literature where prior to actual fighting (court) the parties may affect their fighting skills (Robson and Skaperdas, 2008)).

A common feature of this literature is that if PR are enforceable without cost then an equilibrium with PR provides an efficient output. In our case, even if the cost of property rights enforcement is small, PR are not always established. Our paper is also similar to the spirit of DeMeza and Lockwood (1998) where PR do not necessarily improve the incentive to work hard in a situation where bargaining process follows different rules compared to standard property rights approach. In Rajan and Zingales (1998) the establishment of PR is not always optimal when the parties are concerned about access to critical resources. The origin of PR is not studied in these papers. In the former, possible outcomes include different ownership structures and in the latter, there is an initial owner of the machine. A situation where PR are not established does not arise. However, their ideas are similar to ours in that ownership may reduce the parties' incentives to invest efficiently. The rest of the paper is organized as follows. Section 1 introduces the model and some preliminaries about the first-best solution when it is possible to write a complete contract enforceable without cost. Section 2 analyzes an incomplete contract model and provides the main result. Section 3 analyzes the model with technical progress. Model predictions are discussed in Section 4 and Section 5 provides the conclusion.

2. The Model

² A similar effect can be observed in transition economies. For example, the Russian economy during the period after the socialist system collapsed is an excellent example. The oligarchs or agents with high political power were not always interested in specifying clearly defined PR (Politchchuk and Savvateev (1997), and Hoffman (2002)).

There are two risk-neutral parties A (he) and B (she) which can produce a good by using an IP. The value of the good depends on who is involved in the production process (A , B , or both) and on the level of investments made prior to production (e_1 provided by A and e_2 provided by B). The cost of investment is $c(e_i) = e_i^2, i \in \{1, 2\}$. The investments are non-verifiable. Hence, the parties cannot write a complete contract specifying the levels of investment because it cannot be enforced. Similarly, the parties are not able to write a contract which specifies their final payoffs w_1 (for A) and w_2 (for B) as a function of the good's value. This is because it is impossible to describe every possible situation (state of nature). The good which is to be produced cannot be described at the initial date (when the parties first meet). The class of contracts that can be written ex-ante is restricted to the allocation of ownership rights and money transfers. Ownership of IP is interpreted as the right to control the use of IP (in the example with solar energy if one party is the owner of IP and the parties fail to cooperate after the investments are made, the other party cannot use material X in conditions Y to produce solar energy). However, the parties can also decide not to allocate property rights related to IP.

The interaction between the parties is as follows. It involves 3 stages that will be called initial contracting, investments and production. The two parties meet at the beginning of stage 1 and bargain about who owns the IP. This decision is denoted by σ . $\sigma = a$ means that A owns the IP, $\sigma = b$ means that B owns the IP, $\sigma = n$ means that property rights are not established.³ To convince each other, the parties can make payments. In stage 2, the parties choose e_1 and e_2 . In the beginning of stage 3, the parties observe e_1 and e_2 and the potential value of the good $v(e_1, e_2)$, which can be created if they cooperate. The parties meet again to discuss whether they will cooperate and how they will divide the potential surplus from cooperation. If an agreement is reached, the parties cooperate. Consequently, they write a contract which determines their payoffs w_1 and w_2 and both parties participate in production.⁴

If the agreement fails, the parties do not cooperate. Now, the scenario in case an agreement is not reached depends on whether property rights were established in stage 1 by initial bargaining. If they were, and if A owns the IP, say, his utility will be $u_1(e_1)$ and the utility of B will be 0; and if instead B owns the IP then her utility will be $u_2(e_2)$ and the utility of A will be 0. We assume that $v(e_1, e_2) = u_1(e_1) + u_2(e_2)$, $u_1(e_1) = pe_1$ and $u_2(e_2) = (1 - p)e_2$. These specifications can be interpreted as follows. The utilities from individual usage of the IP depend on the level of effort in stage 1. If A owns the IP then his effort also increases her payoff if cooperation with B does not occur. This is because he can alternatively use the IP in order to produce a good.⁵ Also

³Joint ownership is ruled out. One can assume, for instance, that in this case both parties have veto power on the usage of the IP (Hart, 1995). This makes their default payoffs equal to zero which is suboptimal. Alternatively, one can assume that the usage of the IP will depend on the political power of the agents. This scenario is equivalent to the absence of property rights. One can make some additional assumptions related to joint ownership (that can make it different from absence of PR scenario). For example, in the presence of asymmetric information joint ownership can mitigate some asymmetric information problems between parties (see, for instance, Li, 1996). The analysis of these additional features is out of scope of present paper.

⁴As in the property rights approach it is assumed that the moral hazard problem in this last production stage is negligibly small compared to relationship-specific investment e_1 and e_2 (like investment in human development or in IP development). The introduction of additional moral hazard problems will not significantly affect the results of the paper.

⁵The parties' utilities from individual usage of the IP do not depend on their partner's effort. The utilities depend on investment in their human capital, not in the IP; i.e., the parties are indispensable. Also, the utilities from individual consumption are not transferrable.

$$\max\{u_1(e_1), u_2(e_2)\} < v(e_1, e_2), \forall e_1, e_2 \quad (1)$$

which reflects the effect of relationship-specific investments on cooperation. The crucial feature of our model and what makes a major difference with standard property rights approach is that in case PR were not established at stage 1, and an agreement is not reached in the beginning of stage 3, the parties will fight for the IP. These may include activities similar to those described in case of fixing property rights by either party and on top of that it may include competition with other party. This may require political skills, lobbying etc. Further we will call this race for PR (a similar term used in the literature is "patent race") a fight for the ownership. If A wins the fight he becomes the owner of the IP. The probability of this equals f . A higher f means an improvement in the expected fighting skills of A . Ultimately, this implies that the renegotiation outcome at stage 3 and respectively the efforts at stage 2 depend on the parties fighting skills.

When choosing σ at stage 1 the parties maximize their total expected surplus $\pi(\sigma) = \pi_1 + \pi_2$, where $\pi_i = w_i - c(e_i)$, $i \in \{1, 2\}$. There is bargaining at stages 1 (when the parties determine property rights) and 3 (where the parties determine the shares of the surplus from cooperation). As in the property rights approach, we assume that the parties will choose an option which provides them with the maximal total surplus. At stage 1 the parties will get their default payoffs (if n is chosen) plus a part of total surplus if the scenario a or b has higher surplus than n .⁶ As was mentioned above, at stage 3 the default payoffs depend on who owns the IP. If the parties are able to write a contract (enforceable with no cost) which specifies the levels of effort e_1 and e_2 (complete contracts scenario), then the first-best effort levels will be achieved. The ex-ante efficient effort level maximizes the total expected surplus. If we denote the efficient effort levels by e_1^* and e_2^* then $(e_1^*, e_2^*) = \arg \max_{e_1, e_2} \{v(e_1, e_2) - c(e_1) - c(e_2)\} = \arg \max_{e_1, e_2} \{pe_1 + (1-p)e_2 - e_1^2 - e_2^2\}$. The solution is $e_1^* = p/2$, $e_2^* = (1-p)/2$, and the first-best surplus equals $\frac{p^2 + (1-p)^2}{4}$. Intuitively, the optimal level of investment by a party increases with the productive capacity of this party.

The steps to solve the model in the case of incomplete contracts or when a complete contract that describes e_1 and e_2 is impossible to write are as follows. We use backward induction. First we analyze bargaining in stage 3 after the parties made their investments and they bargain about the allocation of future surplus. If one of the parties has property rights it also has more bargaining power since its default payoff is relatively high. If neither party has property rights, the default payoffs are determined by potential fight which may take and may not take place in equilibrium. Next, we analyze investment decisions. Their choices will maximize the parties' profit as a difference between the anticipated revenue in stage 3 and the costs of investments. Finally, the initial bargaining over the property rights allocation is analyzed. The parties will chose an outcome that maximizes total surplus.

Production: By backward induction we first consider stage 3. In stage 3 the parties always cooperate and fight never occurs in equilibrium. Intuitively, since no additional surplus is created if the parties do not cooperate, the parties are always better off if they form an agreement in stage 3. The equilibrium in stage 3 depends on whether property rights were determined in stage 1. IP ownership is relevant because it determines the threat point of the stage 3 bargaining game. If A owns the IP, the default payoff of A is $u_1(e_1)$ and that of B is zero. If the negotiation takes place, the total payoffs will be $v(e_1, e_2)$. The total gain from cooperation is $v(e_1, e_2) - u_1(e_1)$. According to the Nash bargaining solution, the parties receive their default payoffs plus half of the gains from cooperation. Thus, the payoffs of A and B respectively will be:

⁶Since neither party is wealth-constrained, the specific mechanics of bargaining about the price in stage 1 are irrelevant. It can affect the price but not the choice of σ . The optimal scenario, which maximizes the total surplus, will always be chosen.

$$1/2(v(e_1, e_2) + u_1(e_1)) \quad (2)$$

$$1/2(v(e_1, e_2) - u_1(e_1)) \quad (3)$$

Similarly, if B is the owner and cooperation is optimal, the payoffs are:

$$1/2(v(e_1, e_2) - u_2(e_2)) \quad (4)$$

$$1/2(v(e_1, e_2) + u_2(e_2)) \quad (5)$$

It is clear from (2)-(5) that the payoff of the owner of the IP (resulting from the negotiation in stage 3) is higher than that of the other party.

If the property rights have not been determined in stage 1, then stage 3 has the following timing of events: 1. The parties meet and discuss the division of surplus from potential cooperation. 2. If the agreement is reached the parties produce the good and share surplus. If the agreement is not reached, the parties fight. If the negotiation fails, then A wins the fight with probability f and in that case his payoff equals $u_1(e_1)$. Respectively, B wins with probability $1-f$ and her payoff equals then $u_2(e_2)$.⁷ Hence the total expected payoff will be $fu_1(e_1) + (1-f)u_2(e_2)$. If the negotiation takes place, then the total payoffs will be $v(e_1, e_2)$. The total gain from trade is thus $v(e_1, e_2) - fu_1(e_1) - (1-f)u_2(e_2)$. According to the Nash bargaining solution, A gets half of the gains from trade at date 2.

Thus, the payoffs of A and B respectively will be

$$1/2(v(e_1, e_2) - (1-f)u_2(e_2) + fu_1(e_1)) \quad (6)$$

$$1/2(v(e_1, e_2) + (1-f)u_2(e_2) - fu_1(e_1)) \quad (7)$$

These formulas show that when property rights are not determined when the payoff of a party resulting from negotiation in stage 3 increases in its fighting capacities.

Investments: Again, the equilibrium depends whether the property rights were determined in stage 1. Consider the case when A has the property rights. The equilibrium depends on the parties expectations about the outcome of the negotiation in stage 3. The parties can play strategically in stage 2 to achieve suitable equilibrium in next stage. We first describe A 's choice of effort for a given level of effort by B . By (2) A chooses the effort level $e_1^{**} = \arg \max_{e_1} \{ 1/2(v(e_1, e_2) + u_1(e_1)) - e_1^2 \}$. Thus:

$$e_1^{**} = p/2 \quad (8)$$

From (3) B chooses the effort level $e_2^{**} = \arg \max_{e_2} \{ 1/2(v(e_1, e_2) - u_1(e_1)) - e_2^2 \}$. We have:

$$e_2^{**} = (1-p)/4 \quad (9)$$

When B owns the IP

$$e_2^{**} = (1-p)/2 \text{ and } e_1^{**} = p/4 \quad (10)$$

It follows from the analysis above that (with respect to the first-best scenario) the owner of the IP provides a higher effort than the other party. Now consider investments when PR were not established in stage 1.

⁷This way of modeling the "patent race" is chosen for simplicity. The major insights of the paper will hold under alternative fighting scenarios as well. Also introducing the cost of fighting in the model will not change the results.

We first describe A 's choice of effort for a given level of effort by B . A chooses the effort level e_1^{**}
 $= \arg \max_{e_1} \{ 1/2(pe_1 + (1-p)e_2 - (1-f)(1-p)e_2 + fpe_1) - e_1^2 \}$. Thus:

$$e_1^{**} = p(f+1)/4 \quad (11)$$

Now we consider B 's choice of effort for a given level of effort by A . B chooses the effort level e_2^{**}
 $= \arg \max_{e_2} \{ 1/2(pe_1 + (1-p)e_2 + (1-f)(1-p)e_2 - fpe_1) - e_2^2 \}$. Solving this problem we get:

$$e_2^{**} = (1-p)(2-f)/4 \quad (12)$$

If property rights do not exist, the effort of a party increases in both its productive and fighting capacities.

initial contracting: We first find the parties payoffs and joint surplus in case property rights are fixed in initial agreement. Afterwards we will consider the "no property rights" scenario. Finally we will analyze the results of initial bargaining about property rights. When PR were fixed in the beginning of stage 1, the total surplus equals $pe_1^{**} + (1-p)e_2^{**} - (e_1^{**})^2 - (e_2^{**})^2$, where e_1^{**} and e_2^{**} depend on σ , the stage 1 decision about the allocation of property rights. If A owns PR then its payoff is $1/2(pe_1^{**} + (1-p)e_2^{**} + pe_1^{**}) - (e_1^{**})^2$ and that of B is $1/2(pe_1^{**} + (1-p)e_2^{**} - pe_1^{**}) - (e_2^{**})^2$. From (8) and (9) we have

$$\pi_1(a) = \frac{(1-p)^2}{8} + \frac{p^2}{4} \quad (13)$$

$$\pi_2(a) = \frac{(1-p)^2}{16} \quad (14)$$

$$\pi(a) = (4p^2 + 3(1-p)^2)/16 \quad (15)$$

Similarly we get

$$\pi_1(b) = \frac{p^2}{16} \quad (16)$$

$$\pi_2(b) = \frac{(1-p)^2}{4} + \frac{p^2}{8} \quad (17)$$

$$\pi(b) = (4(1-p)^2 + 3p^2)/16 \quad (18)$$

If property rights are not fixed ($\sigma = n$), we have no ownership scenario and the A 's payoff is $1/2(pe_1 + (1-p)e_2 - (1-f)(1-p)e_2 + fpe_1) - e_1^2$, where e_1 and e_2 are determined by (11) and (12).

Finally from (11) and (12)

$$\pi(n) = (p^2(f+1)(3-f) + (1-p)^2(2-f)(2+f))/16 \quad (19)$$

Proposition 1. If $p \geq 1/2$ then $\sigma = a$ if and only if:

$$\frac{p^2}{(1-p)^2} \geq \frac{1+f}{1-f} \quad (20)$$

Otherwise $\sigma = n$. If $p < 1/2$ then $\sigma = b$ if and only if:

$$\frac{(1-p)^2}{p^2} \geq \frac{2-f}{f} \quad (21)$$

Otherwise $\sigma = n$.

Proof. Consider first the case when A is at least as productive as B ($p \geq 1/2$). It follows from (15) and (18) that $\pi(a) \geq \pi(b)$. From (15) and (19) $\pi(a) \geq \pi(n)$ if and only if (20) holds. The proof is similar for the case $p < 1/2$. *End proof.*

The less productive agent never has the PR in stage 1 equilibrium. Secondly, if one compares a and n (in case A is more productive), then $\sigma = a$ (or high-power incentive for A) should be chosen if A is sufficiently more productive than B (since the left side of (20) increases in p). Also, we have two following results.

Corollary 1. *For any p , there exists $0 \leq f^*(p) \leq 1$ such that for $f > f^*(p)$, $\sigma = n$ is an equilibrium and for $f < f^*(p)$, $\sigma = a$ is an equilibrium.*

Proof. It follows immediately from (20), noting that $f^*(p) = \frac{p^2 - (1-p)^2}{p^2 + (1-p)^2}$. *End proof.*

The meaning of the above result is that when f is low, fighting is costly because A is not as skillful at fighting as B and thus A will underinvest. Second, when f is high, fighting may provide a better incentive than ownership. The incentive for A is high because his fighting skill is high and the incentive of B is always better than in the case of A -ownership because there is a possibility of gaining the property rights.

Corollary 2. *For any $f > 0$, there exists $p^*(f)$ such that for $p < p^*(f)$ the equilibrium is $\sigma = n$; otherwise the equilibrium is $\sigma = a$.*

Proof. It follows immediately from (20) noting that $p^*(f) = \frac{\sqrt{1+f}}{\sqrt{1+f} + \sqrt{1-f}}$. *End proof.*

When agents are equally productive or A is not much more productive than B , fighting is better. This is because A -ownership destroys the incentive of B who is potentially quite productive. When p increases, A -ownership becomes better because the high effort of A is more important than the low effort of B . In both cases, A underinvests but B overinvests more than A underinvests.

Welfare analysis: From (15), if $\sigma = a$ the welfare (total surplus) increases in p . Intuitively, if the situation where property rights belong to A is optimal, an increase in his productive skills compared to B is efficient. This is because his effort is more important in the total surplus and the latter is more sensitive to the changes in A 's effort level. On the other hand, the effect of changes in p on welfare in the case where $\sigma = n$, is ambiguous as follows from (19). Now consider the effect of changes in fighting skills (when $\sigma = n$) on welfare.

Proposition 2. *If $\sigma = n$ and*

$$\frac{p^2}{(1-p)^2} \geq 2 \quad (22)$$

an increase in f improves welfare.

Proof. From (19) the welfare improves if and only if :

$$f < \frac{3p^2}{2p^2 + 2(1-p)^2} \quad (23)$$

If (22) holds the right side of (23) is greater than 1. *End proof.*

If (22) does not hold then the effect of changes in f on welfare is ambiguous. Proposition 2 implies that if the difference in productive skills is large enough then a differentiation in fighting skills improves welfare.

3. Implications

The results of our paper have the following implications.

- Property rights do not necessarily emerge even when the costs of enforcement are low (Proposition 1).
- If the cost of fighting is sufficiently high, the emergence of ownership by the more productive party is more probable if the productive party has weak fighting skills (Proposition 1 and Corollary 1).
- If both productive and fighting skills are high, the emergence of property rights belonging to the more productive party is less probable (Proposition 1 and Corollary 2). When high productivity is combined with a strong fighting ability, property rights will not exist. The more productive agent with strong fighting abilities will know that his stake would be high as a result of ex-post fighting. The less productive agent has some probability of receiving the property rights in ex-post fighting that will improve his effort.
- If property rights are not assigned and the difference in the parties productive skills is large enough, an increase in the difference between the fighting skills of the parties (the more productive agent becomes a more skillful fighter) improves welfare (Proposition 2). Point 4 can explain why more productive researchers often acquire more political power (become department chiefs, deans, etc.) when they become sufficiently more productive than other researchers. There exists an important trade-off between competition policy and PR on IP which can reduce competition. Legal authorities, lawyers and economists dealing with IP should remember that IP laws should ideally encourage innovation up to the optimal level, but no further, because overly strong IP laws interfere with competition and therefore reduce welfare unnecessarily. This paper argues that authorities should also take into consideration that in many cases researchers themselves can surprisingly find an environment without established PR economically more efficient. One line of explanation for this phenomenon in existing literature is related to costly establishment and costly enforcement of PR. As we discussed earlier the evidence related to this point is very ambiguous. In this paper we argue that possible absence of PR on IP can be based totally on economic incentives. In some cases PR will optimally not be established, even if the laws are well developed and enforcement costs are negligibly small.

This paper also provides some quantitative framework for how to deal with the problem of IP. Authorities may either improve IP law which usually will provide additional benefits for parties to establish PR or to improve antitrust law which presumably can increase benefits from not establishing PR. We have shown how to optimize social welfare in different types of situations. In different situations the solution can be different. In practice the balance has at least until quite recently been biased in favor of IP law and against antitrust law. There are some signs that this is changing and that authorities now consider more carefully the balance between IP law and antitrust law, especially in patent law, where the Supreme Court has intervened to reduce the power of patents in some significant respects.⁸ There are also reasons to think the power of patents may be reduced further in the next few years, as the Court decides the KSR case⁹ on the obviousness standard for patentability and as Congress considers proposals for patent reform.

Creating this new, more equal balance will, I concede, create more cases of direct conflict between patent and antitrust, particularly during periods of expansive IP rights.¹⁰ It will also create gaps during periods of low

⁸See *eBay, Inc. v. MercExchange LLC*, 126 S.Ct. 1837 (2006); *Medimmune, Inc. v. Genentech, Inc.*, 127 S.Ct. 764 (2007).

⁹*Teleflex, Inc. v. KSR Int'l, Co.*, 119 Fed. Appx. 282 (2005), cert. granted, 75 U.S.L.W. 3262 (U.S. June 26, 2006) (No. 04-1350).

¹⁰This sort of balancing is one explanation for the European Court of Justice's approach in the *Magill* and *IMS*

protection, when patent owners are free to expand their rights by contract without antitrust interference. But those changes are the price we must pay to stop the incessant swinging of the pendulum, and to try to achieve the goals IP and antitrust share. As a direction for future research we think that the framework developed in this paper can be used to analyze privatization decisions. This is because the state ownership can be considered as an analogous to no ownership scenario. Suppose, for example, that there are two competing managerial teams in an enterprise. Points 1-3 then imply that politically strong team (better fighting ability in our model) is not always interested in privatization. Although the following is not directly related to above scenario it is consistent with the spirit of above results: the oligarchy or agents with political control are not always interested in the existence of property rights and often prefer political games to the allocation of property rights (bargaining without property rights in terms of our model). In existing literature the term "oligarchy" has been applied to the ruling elite in Imperial Japan (Ramseyer and Rosenbluth, 1995), as well as families possessing enormous political power in Latin America (Dosal, 1995) and East Asia (Claessens et al, 2000, Johnson et al, 2000, Johnson and Mitton, 2001) as measured by La Porta et al (1997, 1999). Transition experience provides another telling example. Russian "oligarchs" is a small group of politically influential people. Having accumulated enormous wealth and political power, they effectively blocked any government attempt to create a system of clearly defined property rights (Polishchuk and Savvateev, 1997, Hoffman, 2002, Stiglitz, 2002) for state assets.

4. Conclusion

This article analyzes the formation of property rights on intellectual property. We consider a situation where two agents decide whether to agree on property rights or whether to not fix them at all. It is impossible to write a complete contract determining optimal production efforts. Property rights can improve the incentive of one party and worsen the incentive of another party. The main results we obtain are as follows: 1) Property rights do not always emerge even when the costs of enforcement are low (in some cases the parties may decide to not to determine property rights); 2) Property rights belonging to the more productive party is more likely when he has low fighting skills; 3) When productive and fighting skills are both high, then property rights belonging to the more productive party is less likely and; 4) If property rights are not assigned, and the difference in the parties productive skills is large enough, an increase in the difference between the fighting skills of the parties (the more productive agent becomes a more skillful fighter) improves social welfare.

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Health cases, which used antitrust law to override what in both cases was an illadvised application of IP protection. See Case C-418/01, IMS Health GmbH & Co. OHG v. NDC Health GmbH & Co. KG, (2004) E.C.R. I-5039; RTE v. Commission (Magill), (1995) E.C.R. I-743, (1995) 4 C.M.L.R. 718. The risk is that the European approach goes to the opposite extreme of the pendulum, giving antitrust primacy over IP rather than balancing the two. See First (2006): EC approach " places intellectual property inside competition policy" .

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