Private Agreements for Coordinating Patent Rights: The Case of Patent Pools

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November 12, 2010

When the background legal principles threaten to waste resources, people often rearrange rights sensibly and create order through private arrangements. (Heller and Eisenberg, 1998)

I. Introduction

Since 1982, changes in the U.S. patent office, a restructuring of the courts, and an expansion of intellectual property rights to new product areas have made patents easier to acquire and enforce in the United States. An explosion of litigation activity followed these changes, as patent and copyright holders exercised their intellectual property rights against alleged infringers. The threat of litigation has been acute in several technological areas – computers, electronics, semiconductors, telecommunications, software, business methods and biotechnology – where new products typically improve upon or require use of existing patents.[2] To avoid legal suits, developers of these products have been forced to negotiate with multiple patent owners, stacking up royalty obligations in the process, and sometimes abandoning R&D on the innovation altogether.[3] These developments over the

[1]Professor of Economics, University of British Columbia. This paper is an updated version of a lecture presented at the 2004 International Summer School of Economic Research on *Intellectual Property, Innovation and Competition* at the University of Siena, Italy. I would like to thank Sebnem Ucar for her research assistance, the seminar participants at the University of Siena Summer School and Politecnico di Milano, Reiko Aoki, Suzanne Scotchmer and Ralph Winter for their helpful comments, and the Social Science and Humanities Research Council of Canada for generous support.

[2]See, for example, Lanjouw and Lerner (1998), Lanjouw and Schankerman (2001) and Hall and Ziedonis (2001).

[3]This situation, referred to as the "tragedy of the anti-commons" (Heller and Eisenberg, 1998), occurs when too many individuals have rights to exclude access to a scarce resource, thereby resulting in underutilization of the resource (in contrast to the "tragedy of the commons" in which too many individuals have open access to a commonly-owned good).

past few decades have led some economics and legal experts to conclude – contrary to conventional belief – that the strengthening of patent rights has frustrated, rather than supported, incentives to innovate (Bessen and Meurer (2008); Jaffe and Lerner (2008); Bodrin and Levine (2009)).[4]

When entangled in this "patent thicket", patent holders often participate in private arrangements for sharing their technologies, thereby circumventing the costs of lengthy court challenges.[5] Cross-licensing agreements, for example, facilitate the exchange of portfolios of patents between owners of intellectual property (IP).[6] Alternatively, where several patents are essential for meeting a standard, firms may agree to pool their patents and coordinate licensing of their combined patents to each other and third-party users of the technology (*e.g.,* MPEG-2, DVD ROM and DVD Video standards).[7] Another category includes IP clearinghouses and copyright collectives (such as the American Society of Composers and Performers), which collect information for users of technologies, thereby reducing transaction costs of searching and choosing among available IP options.[8]

This paper examines the second category – patent pools -- with particular focus on arrangements that combine complementary patents. As recognized by antitrust authorities in the U.S. and elsewhere, such pools can have "pro-competitive benefits by integrating complementary

[4]These studies call for significant changes to the patent system that range from new reforms for raising the standards of the examination process to improving notice of the scope of patent rights and strengthening the non-obvious and enablement standards to the outright abolishment of the patent system as it currently exists. The theoretical literature has also given considerable attention to the benefits and costs of a patent system and alternative incentive mechanisms for encouraging R&D. See, for example, Bessen and Maskin (2009) and Gallini and Scotchmer (2002).

[5]A patent thicket arises there are overlapping patent rights which must be identified and licensed in order for an innovator to bring a new product or technology to market (Shapiro (2001)).

[6] For example, see Arora et.al. (2001) for an extensive analysis of cross-licensing and other forms of licensing in technology markets.

[7]Other licensing restrictions also might be used to resolve disputes; for example, grant-backs (the requirement that a licensee agrees to license all future improvements), tying (licensing a patented technology with another patented or unpatented product), exclusivity (licensing a technology to only one licensee or requiring the licensee to deal with only the licensor), non-assertion clauses (commitment not to assert IP rights against contracting parties) and joint ventures.

[8]For example, see Merges (1996) and Aoki and Schiff (2008) for a discussion of institutions for coordinating intellectual property rights and an analysis of market mechanisms that give rise to these institutions.

technologies, reducing transaction costs, clearing blocking positions, and avoiding costly infringement litigation."[9]

Patent pools also have the potential of suppressing competition if, for example, its members collectively harbor nonessential, weak or invalid patents. Moreover, when the pool supports a standard, network externalities can turn IP into an effective instrument for leveraging control on products outside of the pool. Potentially offsetting the benefits of reducing threats of legal reprisal and costs of negotiating multiple licenses, a pool can dampen incentives to conduct research on innovations that compete with the pooled patents. Whether or not these antitrust concerns apply to pools with *complementary* patents is explored in this paper.

More broadly, the paper synthesizes the ideas advanced in the economics literature that contribute to our understanding of the efficiencies and potential anticompetitive effects of these cooperative agreements. Section II provides a brief review of some prominent court cases as well as a discussion of the *U.S. Department of Justice-Federal Trade Commission Guidelines for the Licensing of Intellectual Property* (1995) (hereafter, the *Guidelines*). Approaches for implementing the *Guidelines,* as they apply to patent pools, are presented in Section III. Section IV explores potentially anti-competitive effects of patent pools identified in the economics literature. Section V concludes with an evaluation of the recent approach adopted by the US Department of Justice and directions for further research.

[9]Section 5.5 of the *Guidelines.*

II. History of Antitrust Toward Patent Pools

This section provides some highlights of the history of antitrust decisions regarding patent pools in the United States.[10] Starting with *Bement & Sons v. National Harrow (1902)*[11] and continuing for a decade, patent laws tended to eclipse antitrust laws. In this landmark case, twenty-two firms with 90% of manufacturing float spring tooth harrows transferred their patents to a holding company, National Harrow. They jointly licensed their patent portfolios, fixed prices and required licensees not to deal with products outside the pool or to challenge patents in the pool. Nevertheless the Supreme Court concluded that:

"…the general principle is absolute freedom in the use or sale of rights under the patent laws of the United States. The very object of these laws is monopoly, and the principle is, with few exceptions, that any conditions which are not in their very nature illegal…imposed by the patentee and agreed to by the licensee…will be upheld by the courts."[12]

The absolute freedom patentees had to coordinate activities through patent pools ended by the second decade of the 1900s. A new, harsher view was adopted by the courts and continued through much of the 1900s. A prominent example is the decision in *Hartford-Empire* (1945)[13]. Controlling over 600 product and process patents in the manufacture of glassware, the Hartford-Empire pool dominated 94% of the product market in the United States and imposed several restrictions on the licenses to its members. The District Court found that antitrust concerns trumped patent rights in this case:

"It is said on behalf of Hartford that. . .in order to protect its legitimate interests as holder of patents for automatic glass machinery, it was justified in buying up and fencing off improvement

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[10] See Gilbert (2004) for a comprehensive review.

[11] *Bement v. National Harrow Co.,* 186 U.S. 70 (1902).

[12] *Id.* at 91.

[13] *Hartford-Empire Co. v. United States,* 46 F Supp 541 (N.D. Ohio 1942), 323 U.S. 386 (1945).

patents, . . .The explanation fails to account for the offensive and defensive alliance of patent owners with its concomitant stifling of initiative, invention, and competition."[14]

In contrast to *Hartford-Empire*, the facts in *United States v. Line Material* (1948)[15] suggest a relatively benign impact on competition, but this case was dealt with no less sharply by the Supreme Court. The Line Material patent pool, which included Southern's basic patent and Line Material's improvement, is an example of "one-way blocking." Line Material received an exclusive license on the basic patent and, therefore, the power to set prices under both patents. Although the Court recognized that cross-licensing could promote efficient production ("…only when both patents could be lawfully used by a single maker could the public…obtain the full benefit of the…inventions"), it nevertheless concluded that:

"*the agreement between Southern and Line for Line's sublicensing of the Lemmon patent was to combine in Line's hands the authority to fix the prices of the commercially successful devices embodying both the Schultz and Lemmon patents. . . A contract to fix or maintain prices…has long been recognized as illegal under the Sherman Act."*[16]

Antitrust concerns remained paramount.

This very issue of explicit price fixing was the factor distinguishing *Line Material* from the earlier *Standard Oil* case (1931). The Supreme Court, in reversing a district court finding that Standard Oil's patent pool was illegal, acknowledged that cross-licensing of blocking patents could bring social benefits. In *Line Material* it too recognized that "there is nothing unlawful in the requirement that a licensee should pay a royalty to compensate the patentee for the invention and the use of the patent", but on the other hand disapproved the "use of the control that such cross-licensing gives to fix prices."[17] The Court did not recognize, however, that a royalty could generate the same outcome as price fixing,

[14] *Id.* at 407.

[15] *United States v. Line Material,* 333 U.S. 287 (1948).

[16] *Id.* at 291 and at 307.

[17] *Id.* at 315.

thus rendering the distinction between royalty arrangements and cross-licensing inconsequential. In this case, the Court's ruling may have prevented an efficient patent sharing arrangement.

By the 1980s the pendulum began to swing back and settle on a more moderate stance. As articulated in the *Guidelines* (1995), patent licenses have been viewed more recently as generally pro-competitive unless it can be shown that competition has been reduced relative to that which would have occurred absent the agreement.[18] This doctrine, extended from licensing agreements to patent pools, has permitted pools and similar organizations comprising components that are *complementary, valid and essential* in order to satisfy standards for production and use of downstream products.[19] Examples include pools formed to implement the MPEG-2 video compression, DVD-Video and DVD-ROM standards and the 3G mobile platform.[20] In these cooperative agreements, each firm's patents covered a small but essential component, the collection of which was necessary to develop new products; licensees were free to use alternative technologies; and the pooled patents could be licensed both individually and as a bundle. We turn now to an economic analysis of this view articulated in the *Guidelines* and its implications for the design of welfare-improving patent pools.

[18] Not all patent pools have passed the test set out in the *Guidelines.* For example, a pool between two companies, Summit Technologies and Visx, each claiming to hold essential patents for the manufacture of laser eye surgery machines, was forced to dissolve in 1998 since the FTC noted that the two firms would have been competitors in the market for equipment that used their respective patents.

[19] A component is essential if it is technically required and has no close substitutes (Gilbert, 2009).

[20] Gaulé (2006) notes that pool formation is less common in the biomedical area and pharmaceuticals; however, in 2009 GlaxoSmith Kline introduced a patent pool for combating neglected diseases and UNITAID recently approved an agreement to open a Medicine Patent Pool foundation (see Gold, et.al., 2007).

III. Implementing the Guidelines: The Product and Litigation Rules

As noted in the previous section, the more recent approach for evaluating patent pools, advanced in the *Guidelines*, balances the rights of IP holders with the benefits of competition. Precisely what this implies about the characteristics of permissible patent pools is examined in this section. Two approaches for identifying welfare-enhancing patent pools, referred to as the *Product Rule* and the *Litigation Rule* in this paper, are presented and compared.

A. The Product Rule

Throughout the history of antitrust, the nature of restrictive licensing terms (*e.g.,* resale price maintenance, exclusive territories, non-compete clauses) has been a primary focus in the evaluation of potential antitrust violations of patent pools. The *Guidelines* shifts the focus to the determination of potential harm to competition among pool members "that would have been actual or potential competitors" outside of the agreement.[21] Restating this principle, Gilbert (2004) suggests that *"antitrust evaluations should begin with a study of the competitive relationships of patents involved in the pool."* This approach for assessing patent pools will be referred to here as the *Product Rule*.

In assessing the impact of the competitive relationship among patents, the polar cases are straightforward: A patent pool with perfect complements that are essential (i.e., technically-required with no substitutes) would be viewed favourably since coordinated pricing leads to lower prices and higher surplus relative to no pool, whereas pools of substitutes without any redeeming features would be suspect. While the polar cases provide a useful benchmark, in practice, cases of perfect complements or substitutes are rarely observed. More commonly, the relationship between patents in

[21] *Guidelines,* Section 5.5, Example 10.

a pool includes elements of both substitutability and complementarity, confounding the distinction between agreements that are beneficial versus anticompetitive.[22] Misdiagnosis of a pool as consisting of essential complements when in fact it contains nonessential substitutes is a risk especially in the early stages of an industry (Lanjouw and Lerner (2001)).

"Two-way blocking" – a situation in which components have value only when used with others to create a new product (e.g., as in the MPEG-2 protocol) – approximates the "perfect and essential complement" abstraction. Others, such as "one-way blocking" in which sales of an improvement can be blocked by a basic patent (e.g., as in Line Material), are more ambiguous since the products are both substitutes and complements: Since the basic and improved products are imperfect substitutes, the relationship between firms is horizontal; but it is also vertical (and complementary) because the basic patent is an input into the production of the improvement.

Reflections on *Line Material* provide insights on the latter, more ambiguous case. Following Gilbert (2004), consider a simple framework in which a basic patent and improvement are valued at v_1 and v_2, respectively, $v_2 > v_1$. If the firms are allowed to form a pool, they will agree to sell the improvement at a price of v_2 and split the profits. Now suppose they are not allowed to enter a pool but firm 1 can offer a royalty licensing contract. Then if firm 1 withdraws from the market, it will set a royalty $R = v_2$ and capture the full surplus.[23] Thus, the cooperative solution is reproduced with consumers receiving the improvement but with zero surplus. Alternatively, firm 1 could refuse to license, in which case consumers would receive only the basic invention and firm 1 would earn v_1; clearly this would be an inferior outcome. This example shows that pools with one-way blocking patents could

[22] See Lerner and Tirole (2004) for an elegant analysis of this issue in which the full range of products from perfect substitutes to perfect complements is considered.

[23] If firm 1 is not allowed to withdraw from the market, then P_1 and P_2 will satisfy: $v_2 - P_2 = v_1 - P_1$ or $P_2 = (v_2 - v_1) + P_1$. Since $P_1 \geq R$, the opportunity cost of firm 1 producing, the improvement will win the market if P_2 is set slightly below $(v_2 - v_1) + R$, yielding positive consumer surplus of $v_1 - R$ if $R < v_1$. However, this would not be an equilibrium outcome since firm 1 could earn v_1 by refusing to license.

improve or achieve the same outcome as the non-cooperative solution; for elastic demands, the elimination of the double marginalization arising between two vertically-related duopolists would make the pool strictly preferred.

In determining the welfare impact of patent pools, the Product Rule focuses on the nature of the competitive relationship between products in the pool. The next section presents an alternative rule that identifies additional criteria to consider.

B. The Litigation Rule

Under the Product Rule, complementarity is sufficient for a pool to be socially desirable. However, when a private agreement is negotiated in the shadow of actual or potential patent disputes that would occur if not for the agreement, complementarity may not be enough to guarantee a welfare improvement. That is, if patent rights are only "probabilistic",[24] consumers may be better off under litigation than under a settlement. Noting that this feature of patents should be recognized in antitrust decisions, Shapiro (2003) recommends that:

"A patent settlement" should not "lead to lower expected consumer surplus than would have arisen from ongoing litigation. This standard…balances the rights of patentees with consumer interests." (p. 396)

The above view is referred to as the *Litigation Rule.* Note that it calls for protection of both the probabilistic rights of the patentee, by ensuring profits that would accrue "under the shadow of patent litigation", and the property right of consumers by ensuring benefits from competition that would

[24] See Lemley and Shapiro (2003) for an examination of probabilistic patents.

otherwise arise from litigation. Under this rule agreements are allowed only if they yield consumer surplus at least as large as in the litigious outcome.[25]

It is straightforward to determine situations under which the Product and Litigation Rules will reach the same conclusions on the welfare effects of patent pools and when they will diverge. First, consider the case of one-way blocking. As noted earlier, if the basic and improvement patent (with respective values v_1 and v_2) are expected to be valid, a simple royalty contract could yield the same consumer (and total) surplus as an agreement in which the firms pooled their patents. Similarly, if the improvement patent is expected to be invalid, then the patentee of the basic patent would be able to block the others from using the improvement and sell it at a price v_2 – again, the outcome under the cooperative settlement. Hence, both rules would permit a patent pooling settlement.

If the *basic* patent is expected to be invalid, however, then the two rules could diverge in their recommendations. To see this, suppose the basic patent is sold in a competitive market (after invalidity is established), and P_1 and P_2 are the respective prices of the basic and improved goods. Then P_1 will fall to zero, constraining P_2 to $P_2 \leq v_2 - v_1$ and yielding a consumer surplus of v_1. Unless a patent pool generates the same consumer surplus, it will not be allowed under the Litigation Rule but may be permitted under the Product Rule in which patent validity is presumed.

The two rules can also be compared in the case of two-way blocking patents. Following the framework in Shapiro (2003), let S_M be the consumer surplus under the pool (or monopoly outcome), S_D the surplus under the non-cooperative (duopoly) outcome, and S_E the free entry outcome if both patents are declared invalid. Patents are assumed to expire at time 1. If the firms pool their patents immediately, they earn S_M; if they are not allowed to do this, they compete as duopolists until time T when litigation occurs. Each patent is valid with probability θ. If neither or one patent is found to be

[25] Shapiro shows robust conditions under which firms settle and it is socially desirable to do so (in that the firms are at least as well off while not harming consumers), consistent with the evidence that 95% of disagreements are settled in the shadow of litigation.

invalid, then the firms are assumed to settle at the pool/monopoly outcome; otherwise, there is free entry and the competitive outcome ensues. Then, the Litigation Rule favours the patent pool at time 0 rather than the duopoly outcome if:

$$S_M \geq T\,S_D + (1-T)\,(\theta^2 + (2\theta(1-\theta)))\,S_M + (1-T)(1-\theta)^2\,S_E \text{ or}$$

$$(1) \qquad \frac{S_M - S_D}{S_E - S_D} \geq \frac{(1-T)\,(1-\theta)^2}{T+(1-T)(1-\theta)^2}$$

Consider two polar cases: Litigation never occurs (T = 1) and litigation is immediate (T = 0). In the first, when T = 1, (1) implies that the pool should be approved if:

$$(2) \qquad S_M \geq S_D$$

For complementary components, coordinated pricing dominates the duopoly outcome since price effects are internalized, thereby satisfying (2). Again, the Product and Litigation approaches reach the same conclusion.

Next consider the other extreme in which litigation occurs immediately: T = 0. A settlement or cooperative agreement (e.g. patent pool) is preferred to litigation if:

$$(3) \qquad S_M \geq S_E,$$

Since (3) does not hold for the conventional case of complements (or substitutes for that matter), a cooperative agreement will not be allowed under the Litigation Rule if the patents are expected to be contested immediately but may be permitted under the Product Rule if the patents are complementary.[26]

[26] But would the patents in fact be challenged in the absence of a pool? In the above model, the timing of litigation is exogenous. If instead the incentive to litigate depends on patent validity, then the two principles may converge. To see this, consider the case of very weak patents (*i.e.,* $\theta = 0$). From (1), a patent pool will be preferred to competition if: $S_M \geq T\,S_D + (1-T)\,S_E$. If, however, firms are not likely to challenge each other in the absence of a pool, as Choi (2009) demonstrates (see the next section), then T would effectively be equal to 1, thereby rendering pools with weak, complementary patents harmless.

At the other end of the spectrum, both rules also appear to favour patent pools with valid patents (*i.e.,* θ is close to 1).[27] To the extent that validity is correlated with "patent strength"[28], this suggests that these rules support an antitrust policy that is more lenient toward cooperative agreements when patents are stronger, that is, an antitrust policy that reinforces rather than constrains patent rights. However, this relationship may not hold if consumer surplus incorporates dynamic as well as static measures of market conditions. In particular, incentives to engage in future research may be greater in a non-cooperative setting, potentially generating a larger surplus for consumers, than under a patent pool.[29] This potential dampening of incentives to innovate under a patent pool and other anticompetitive concerns are examined further in Section IV.

[27] If θ=1, then the inequality in (2) holds.

[28] For example, in Farrell and Shapiro (2008), patent strength is defined as the probability that a patent is found "valid and infringed" if tested in court.

[29] This requires an analysis of the "innovation market", a concept advanced in the Guidelines and defined in Section 3.2.3 as "research and development directed to particular new or improved goods or processes, and the close substitutes for that research and development", which include R&D efforts, technologies and goods that "significantly constrain the exercise of market power with respect to the relevant research and development." The *Guidelines* acknowledge the difficulty of identifying when arrangements may "affect the development of goods that do not yet exist" or "where there is no actual or likely potential competition in the relevant goods." Notwithstanding this challenge, the impact on innovation activity should be considered when evaluating cooperative agreements.

IV. Potentially Anticompetitive Features of Patent Pools

Under the Product and Litigation Rules described above, pools with valid and complementary patents are typically welfare-enhancing. However, this result is based on a simple static framework in which the decisions to litigate, vertically integrate and innovate are either exogenous or not considered. In more complex environments, patent pools – even those combining complementary patents – can have negative welfare consequences if they reduce incentives to challenge weak patents, foreclose competition in downstream markets or discourage innovative activity. We turn now to a brief discussion of these extensions for the pooling of complementary patents.

A. Protecting Weak Patents

The potential for patent pools to harbor weak patents as an entry-deterring strategy has been a concern in antitrust cases. For example, according to the Court in *Duplan Corp. v. Deering Milliken Inc.* (1977)[30], the patentees were well aware that their patents were weak and entered the agreements (involving licensing restrictions) in order to prevent challenges to patent validity. Since "a weak patent is a threat to every patent" (Gilbert (2004)), competing firms will have the incentive to enter into an agreement with the purpose of jointly defending weak patents. In contrast, for complementary patents, only one valid patent is needed to preserve the cooperative outcome and so there is less incentive to jointly protect weak patents.

While incentives to defend weak complementary patents are muted, so too are incentives to contest them. This "live and let live" strategy, identified by Choi (2005, 2009), implies that invalid patents would not be contested whether or not a patent pool forms; therefore, a pool would be

[30] 444 F. Supp 648, 682 (D.S.C. 1977).

deemed at least as good as the alternative under the Litigation Rule. Choi, in arguing for a stricter rule, recommends that third parties be given incentives to challenge weak patents and that pools be approved prior to establishing validity *only* if the patents are complements and litigation costs are high.[31]

B. Foreclosing Downstream Rivals from Market

In the previous section, members of the pool produced only the included essential components. Suppose instead that the firms are vertically-integrated, producing both the upstream inputs and downstream final products requiring those inputs, as is characteristic of the recently approved pools.

To determine the welfare consequences of patent pools in this case, consider the framework developed by Kim (2004) in which *m* specialized upstream firms produce differentiated components, *s* specialized downstream Cournot firms produce homogeneous products and *n* vertically-integrated firms operate in both sectors. Upstream firms issue separate licenses or a single license for the bundle of components to the downstream firms, including those which are vertically-integrated and part of the pool. Three externalities are relevant: (1) the complements problem (when complements are sold by separate firms); (2) double marginalization (when upstream and downstream firms sell separately); and (3) raising rivals' costs (when vertically-integrated firms raise input prices to downstream competitors).[32] In the absence of vertical integration, the standard result is reproduced: the royalties and price of the final good fall under the pool because the problem in (1) is eliminated.

[31] For example, under the Hatch-Waxman Act (*The Drug Price Competition and Patent Term Restoration Act*, 1984) for pharmaceuticals, successful challengers are given an exclusive right to the generic market for 180 days. Choi (2005) asserts that third parties generally will not find it worthwhile to challenge weak patents because of the public good nature of doing so; that is, the cost of the challenge is not internalized by all the potential entrants benefitting from it. Farrell and Shapiro (2008) similarly conclude that weak patents licensed to downstream firms that compete with each other (or the licensor) should be subjected to post-grant review, since approving weak patents could have significant *ex ante* and *ex post* negative consequences.

[32] See Salop and Scheffman (1983) and Ordover, et.al. (1990) for an analysis of raising rivals' costs.

Vertical integration introduces the two addition opposing effects noted above when the inputs are not pooled: raising rivals' cost – which has the effect of raising prices – and reducing double marginalization – which has the effect of lowering prices. In addition to the above effects, a pool internalizes the impact of a price increase on the demand for the other inputs in the pool (effect in (1) above), which causes the price to fall relative to the case of no pool. Moreover, a pool "magnifies" the effect in (2) since it internalizes the impact of a high price on pool members' downstream profits. Hence, the result that prices fall under a pool and welfare increases with coordinated prices on complementary inputs is preserved under vertical integration.[33]

Although the model is stylized in its characterization of symmetric downstream firms, it provides insights on the potential for foreclosure. Under vertical-integration, all non-integrated downstream firms are foreclosed from the market when inputs are not pooled, owing to the high royalty rates they face. This stark result would not likely arise in a more general model with differentiated downstream firms but it is nevertheless useful for comparison with the pooled, vertical integration case. There, the downstream firms are not excluded, although there is partial foreclosure since integrated firms effectively face lower royalty rates relative to that paid by non-integrated firms. Therefore, while vertical integration may indeed result in downstream foreclosure, the negative impact is expected to be less under a pool than in its absence.

C. Reducing R&D Incentives in the Upstream Innovation Market

In this section we ask whether a pool dulls incentives to invent around rivals' patents or to discover new technologies related to the pool. Since innovators enter a pool only if doing so increases

[33] See Kim (2004) and Lerner and Tirole (2004) for an analysis of the interplay between vertical integration and patent pools. While their results differ in the impact of vertical integration on the price of the downstream product, they both show that under vertical integration, patent pools will increase welfare for complementary patents (more precisely, if the demand margin binds in the absence of the pool in Lerner and Tirole).

their profits, those prospective members who later join have enhanced incentives to innovate. In fact, since it pays to be an early entrant, the initial period of pool formation may be characterized by overinvestment after which research activity declines, as shown in a model of sequential pool formation by Dequied and Versaevel (2006).

In contrast, e*x post* incentives may be dulled if future inventions developed later must be automatically assigned to the pool. But even if incentives to develop (relatively high-cost) inventions in the future are compromised by this provision,[34] automatic assignment may increase welfare by preventing hold-up and thereby encouraging firms to join efficient pools in the first place (Lerner and Tirole (2004)).

Moreover, free-riding may discourage research by pool members (Aoki and Nagaoka (2004)): After a standard is secured by a pool, firms with complementary inputs may have the incentive to free-ride, either by defecting or not joining the pool. While increasing its own profits by producing independently, a defecting patentee reduces total profits to the pool and, therefore, members' incentives to improve the quality of the standard through R&D. Of greater concern is the destabilizing effect that free-riding may have on efficient patent pools, a situation that worsens with patentee heterogeneity and with allocation rules that divide profits equally or according to the share of patents contributed to the pool.[35]

[34]Mullen and Sicalides (2001) discuss ways to alleviate this concern, which include giving greater weight to newer innovations in the royalty formula; allowing grant-back provisions to be non-exclusive; and calculating royalties on the basis of the actual use of a pool patent.

[35]This discussion is related to the research joint ventures (RJVs) literature. RJVs are similar to a pool in that complementary research outputs are pooled and shared with members who compete with each other in the downstream market. Kamien, Muller and Zang (1992) compare a "competitive RJV" in which the firms independently choose their research levels and a "cooperative RJV" in which they coordinate research. In both cases, R&D efforts are shared and duplication is avoided. Under the competitive RJV, which most closely resembles patent pools, effective R&D is lower than under the cooperative RJV and, in fact, falls below research activity generated under full competition, in which firms compete in R&D and do not share their findings.

From the above discussion of the literature, the following results emerge regarding the impact of complementary patent pools on R&D activity:

(1) *Ex ante* to pool formation, prospective pool members will overinvest in R&D leading up to the formation of the pool, followed by a decline in innovation activity after the pool is formed.

(2) *Ex post* pool formation, patentees have the incentive to free-ride on the standard, which reduces profits and incentives to research, particularly when firms are heterogeneous and equal profit-sharing rules or automatic assignment are in effect. Countering these negative effects are cost savings from reduced litigation among members of the pool and access to discoveries generated by the pool.[36]

The above results are tested by Lampe and Moser (2010a) for the sewing machine patent pool of the 19th century (1856-1877). The pool included complementary patents that were essential for the superior (lockstitch) technology. Members of the patent were free to license their components independently as well as in the bundle; in fact, licensing was encouraged at rates that dropped significantly throughout the life of the pool. Measuring innovation in two ways (patents and stitches per minute), the authors describe a pattern of innovation with (1) high activity prior to the pool formation; (2) a reduction in R&D activity by both the members and outside firms for the duration of the pool; and (3) an increase in innovation after the pool was dissolved, coincident with patent expiration of the pooled patents.

The empirical results show that outside firms reduced innovative activity while focusing on the inferior (chain stitch) technology. An explanation given in the paper is that the outside firms were responding to litigation threats, which appeared more aggressive during the life of the pool than when

[36] In offering a bundle of components, the pool may also generate a positive demand effect since it reduces the costs to users of negotiating multiple licensing contracts required for the production or use of their downstream products.

the patentees operated separately.[37] Reinforcing this effect may have been the fact that the superior technology simply made the pool members more formidable competitors. That is, developing a better, non-infringing substitute may have been too costly, especially given the availability of the relatively low cost option of licensing the pooled technology.[38]

Regarding R&D activity by the pool members, support is found for the theoretical prediction in (1): that innovation activity was high prior to pool formation and declined thereafter. While the decline in research runs counter to the expectation that research should expand in less litigious environments, at least among members of the pool, the free-riding effect of patent pools described above may have dampened incentives to innovate.[39] In providing evidence of the pattern and direction of technological change, this empirical study emphasizes the importance of accounting for innovation market effects when assessing the welfare impact of patent pools.

D. Influencing Prices on Outside Goods

In the previous sections, outside firms selling substitute products influence the welfare implications of patent pools: They may challenge the validity of the pooled patents (section A); compete in the downstream market (section B); or develop substitute products in the upstream innovation

[37] Although the pool members may have been more aggressive in the upstream innovation market, it appears to have been less aggressive in the downstream product market. In particular, the authors note that the downstream firms were reasonably accommodated (royalty rates declined over time), although differential royalties were set for insiders and outsiders. This is consistent with the results from the foreclosure literature under vertical integration reported above.

[38] If a pool consisted only of complementary components, then its members should not have been threatened by an outside replacement that either invalidated or competed with one or more of the inside components; as long as at least one patent remained valid, monopoly profits could have been achieved, whereas in the absence of a pool, the individual patentee being threatened would have had a greater incentive to litigate. If, however, research by outsiders was expected to lead to a competing standard, then the patentees in a pool would have increased incentives to litigate. The alternative explanation – that the superior technology made the patentees stronger competitors – may have intensified with the pool if it allowed the patentees to license strategically in order to reduce competitors' incentives to innovate. Indeed, the authors report that the pool approved licenses to "all applicants whose machine was 'not an offensive imitation of the machine of some other licensed manufacturer'" (Lampe and Moser, 2010b, p.7). See, for example, Gallini (1984) in which licensing is used strategically to deter competitive innovation.

[39] The free-riding argument, however, is suspect since there appeared neither to be automatic assignment of future patents nor defection by pool members.

market (section C). In this final subsection, we shift ownership of those substitutes from outside to inside firms. That is, a member of the pool is assumed here to produce the substitute (or competing standard) for the pooled downstream product.

To explore this further, let X and Y be two inputs produced by firms 1 and 2, respectively, and combined in fixed proportions to produce Z, which is sold in a competitive, downstream market. Furthermore, suppose W is a differentiated substitute for Z, also produced solely by firm 1 as shown in Figure 1. Consider first the case of no pool. Firm 1 chooses the prices of W and X to maximize its total profits, given the price of Y; while Firm 2 chooses its profit-maximizing price of Y, given the prices of X and W. In choosing the prices of W and X, Firm 1 internalizes the positive effect that a price increase has on the demand for the other good, thus placing upward pressure on both prices relative to the case in which W is produced by an outside firm.

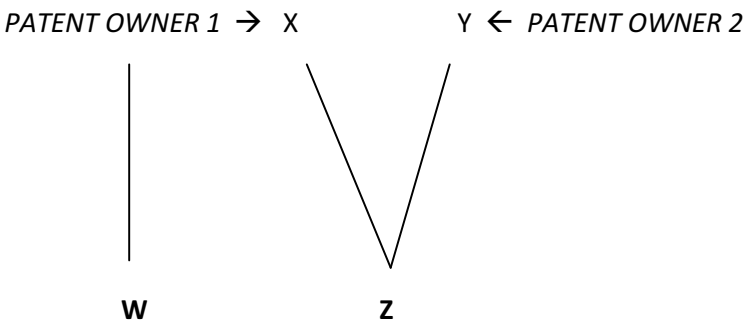

Figure 1

Now suppose the two patent owners pool their components X and Y and coordinate the price of Z by maximizing profits from bundled sales of X and Y, given the price of W. In addition, Firm 1 chooses the price of W to maximize its profits from sales of W and its share of the pooled profits, given the price

of Z set by the pool.[40] As before, Firm 1 internalizes the effect of an increase in the price of W on sales of Z, but this time taking into account its share of the joint profits from the pool.

Preliminary research based on this Bertrand competition framework reveals that the pool can have the effect of reducing *both* prices of Z and W if the downstream products are strategic complements. This result is attributed to the fact that Firm 1 not only internalizes the relationship between W and X but also between X and Y. Since the latter are complements, the price of Z falls; since W and Z are strategic complements, a reduction in the price of Z lowers Firm 1's marginal profit on W and thus the price of W. For this welfare-enhancing outcome to be realized in equilibrium, both firms must have the incentive to join the pool. In the case of quadratic utility, it can be shown that if W and Z are strong substitutes, the profits generated on Z from the pool may not be sufficient to compensate Firm 1 for its loss in profits on W, holding Firm 2's profit at the no-pool level.

This sketch of the multi-product case reveals that an increase in coordination between substitutes brought about by the formation of a pool can increase competition in the downstream market, reducing prices of both the final (pooled) product and its outside substitute.[41] However, this result may not hold for alternative patterns of product ownership and coordination;[42] consequently, antitrust authorities should be circumspect when evaluating competitive relationships between members of the pool. In particular, the Product Rule should be expanded to include an assessment of

[40]This set-up may seem restrictive in that firm 1's profits on W are not included in the maximization problem. In ongoing research, I have also explored the case of full coordination but for the case reported here, the underlying assumption is that including consideration of outside products would be in violation of antitrust laws. Notes on this problem and derivations of the results are available from the author upon request.

[41] For example, if the pool maximizes total industry profits, then the price of W could increase in equilibrium since the pool internalizes the positive effect of raising the price of W on the demand and total profits of Z.

[42]For example, if both firms controlled W and Z such that the pooled outcome maximized total industry profits (on W and Z), then for homogeneous substitutes, the firms in a pool would suppress production of one of the products. Such was the complaint in Princo Corp v. International Trade Commission in which Philips and Sony were in a CD-R/RW pool arrangements that supported the standard Raamaker. The patent misuse case, for which they were vindicated, accused the firms of suppressing another method (Lagadec) on which they held patents.

the relationship between the patentees regarding their products *outside of the pool* as well as their patents *inside the pool*. This is consistent with the message in the U.S. Patent and Trademark Office white paper (2000), which states that: "…pool participants must not collude on prices outside the scope of the pool." [43]

[43] This analysis is closely related to Tepperman (2002) who shows that resale price maintenance (RPM) in licensing contracts can be a mechanism for controlling prices of substitutes of a licensed product. In his model of a multi-product licensee that produces a substitute for the licensed good, constrained by RPM, he shows that for strategic complements, the licensor can extract additional rents through RPM than it would earn by refusing to license, since the licensee internalizes the price of the licensed product on the demand for its other good when setting the price.

V. Conclusions

In this paper, we examine patent pools, their efficiencies and potentially anticompetitive effects. General principles proposed in the *U.S. Guidelines* are reviewed and insights gathered from the economic literature on their implementation through two approaches, referred to as the Product and Litigation Rules. While it is well-established that patent pools integrating complementary components are likely to be socially beneficial, they also can decrease incentives to innovate, discourage members from contesting weak patents and impact prices of outside substitute products. However, as economic research reveals, these effects for complementary patents are expected to be negligible or positive, especially when the patents are *valid and essential*, as in recently-approved patent pools.

While requiring validity is clear, it is debatable whether the "essentiality" condition – that pools should include only technically-required patents without close substitutes – is too strict a litmus test for welfare-increasing pools. Indeed, antitrust concerns over pools with nonessential patents,[44] have an economic basis: Lerner and Tirole (2004) note that if the "competition margin" binds (i.e., the patents in the pool are sufficiently substitutable), a strategic private benefit exists from including non-essential patents in the pool when independent licensing is not allowed.[45] This does not apply to complementary pools, for which the inclusion of nonessential components is neither profitable nor problematic.

The latter result raises the question of whether the essentiality requirement should be relaxed for otherwise permissible pools. Gilbert (2009) believes it should, showing that over-inclusion is not

[44]For example, in a letter to Carey R. Ramos (June 10, 1999), regarding the formation of pools for the DVD-Rom and DVD-video formats, Joel Klein states: *"the inclusion in the pool of only one of the competing non-essential patents,…, could in certain cases unreasonably foreclose the non-included competing patents from use by manufacturers; because the manufacturers would obtain a license to the one patent with the pool, they might choose not to license any of the competing patents, even if they otherwise would regard the competitive patents as superior.*"

[45]This strategy of bundling a nonessential input to a set of essential inputs is similar to the problem on strategic tying developed in Whinston (1990) and related literature.

likely to harm competition as long as the pool includes at least one valid essential patent and patentees are free to license their components independently. This is particularly relevant in areas where standards do not apply or the final product does not yet exist, as in biotechnology and biomedical research, thus making the determination of what is and is not essential difficult at best (Gaulé (2006)).

Notwithstanding these important insights, the issue of essentiality requires further scrutiny. Nonessential patents imply that substitutes exist for the pooled patents and, therefore, the possibility for competing standards to emerge. However, it also raises the possibility that incumbent pools will attempt to prevent new competition from transpiring. As the sewing machine case revealed, when patentees operate jointly, their incentives to litigate may increase. Whether pools facilitate litigation against outsiders, capable of developing competing standards, is a topic worth examining, particularly in light of the rapid technological change and standard formation occurring in consumer electronics and telecommunications.[46] Although not addressing this issue directly, Schiff and Aoki's paper (2007) on multiple standards provides a useful framework for generating insights into this problem.[47]

Since pools with substitutes are likely to be welfare-decreasing, further complexities explored here for complementary pools would only strengthen the case against them. This observation reiterates the central importance of the relationship among products within (and outside) the pool. As noted earlier, these relationships are not always easy to determine and so it would be useful to identify observable indicators – alternatives to complementarity and substitutability – that distinguish between

[46] For example, the potential to restrict ongoing competition was a concern of the U.S. Justice Department in approving the 3G Platform.

[47] In their model, two groups of firms, each supporting a standard (A and B), decide whether or not to pool their respective complementary patents. When the standards are non-compatible substitutes, the decision by one group (say A) to form a pool will not be profitable if the second group (B) decides to do the same thing. However, after B pools its patents, A and B may find it profitable to make their standards more compatible. Under greater compatibility, consumers benefit from the network effects it brings, but they may also face higher prices from a softening of competition. As their analysis suggests, the decision to threaten actual or potential competition with legal action will depend on strategic decisions of pooling and compatibility if the competing standard is actually developed.

welfare-reducing and beneficial pools. For example, as shown by Lerner and Tirole (2004) and Lerner, Stojwas and Tirole (2007), grantbacks (the requirement to license intellectual property related to the pool) and independent licensing are two features that tend to be associated with pools of complements but not substitutes.[48] Hence, the absence of grantbacks or independent licensing in pool arrangements may be a screen for identifying suspect pools. Finding other distinguishing (and observable) features of patent pools would help to sharpen the analysis and reduce the errors that admit anticompetitive pools or reject those that are socially beneficial.

Finally, the dynamic effects of a pool on innovation merit further attention. While several papers have examined the impact of patent pools on *ex ante* and *ex post* research activity, the focus typically has been on the *amount* of investment, rather than on the *composition* of the research.[49] In particular, it may be that in attempting to acquire valuable "bargaining chips" when patents are strong and the prospect of entering a patent pool is imminent, firms may sort themselves into complementary research paths by developing inventions that are valuable complements rather than duplicative substitutes of their rivals' patents. In comparison to duplication of effort that might arise under weaker patents, this endogenous response may offset some of the costs of increased patent protection, possibly restoring a positive relationship between patent strength and (quality-adjusted) innovation.

As noted in the Introduction, several authors have raised concerns regarding the effectiveness of the current patent system, with some even calling for its dissolution. However, recent research counters some of these negative charges. For example, Galasso and Schankerman (2010) provide

[48] When patentees are allowed to sell their components separately as well as in a bundle, prices are constrained for welfare-reducing pools but not in welfare-increasing pools; consequently, independent licensing is unlikely to be observed in the former case.

[49] The direction of technical change is examined for the sewing machine pool in a companion paper by Lampe and Moser (2010b) to the one discussed above. The choice of technology is also explored in Fershtman and Kamien (1992) for firms having the potential to cross licensing and in Eswaran and Gallini (1996) for firms choosing between product and process innovations.

evidence that the establishment of the Court of Appeals for the Federal Circuit may have facilitated technology diffusion by reducing uncertainty, settlement delays and the negative impact of fragmented negotiations. Furthermore, Walsh, Arora and Cohen (2004), in analyzing data from interviews with biotech and pharmaceutical firms and universities, suggest that innovation in drugs has not been impeded by a patent thicket in research tools, although they caution that restricted access to essential upstream discoveries may warrant further scrutiny.[50]

As this debate continues to unfold, careful consideration needs to be given to the private reorganization of IP rights in response to changes in patent policy. The review of patent pools in this paper reveals that private mechanisms can mitigate some of the inefficiencies created by a stronger patent regime, especially in lowering royalties on patented components and promoting competition in downstream markets. Moreover, in assembling a group of related components, patent pools can reduce search and negotiation costs to users, thus promoting technology utilization, as well as disclosure through the expectation of higher profits, both being important functions of a patent system. Less clear, however, is the role of pooling in facilitating innovation in a pro-patent environment. Whether patent pools and other private agreements mitigate or exacerbate the negative effects that have been attributed to recent policy changes remains indeterminate. Greater clarity on this issue would be valuable since, notwithstanding the benefits noted above, policies that strengthen patent rights without generating a strong response to innovate would also be without strong economic justification to perpetuate.

[50] See also Walsh, Cho and Cohen (2005) for further empirical analyses of the impact of patenting on biomedical research and markets for technology.

References

Aoki, R. (2004), "Intellectual Property and Consortium Standard Patent Pools", *Journal of Intellectual Property Rights,* Vol. 10, pp. 206-213.

Aoki, R. and Schiff, A. (2008), "Promoting Access to Intellectual Property: Patent Pools, Copyright Collectives and Clearinghouses", *R&D Management,* vol. 38, no. 2, pp. 189-204.

Aoki, R. and Nagaoka, S. (2004), "The Consortium Standard and Patent Pools", Hiotsubashi University Working Paper.

Arora, A. A., Fosfuri, A. and Gambardella (2001), *Markets for Technology.* Cambridge: MIT Press.

Bessen, J. and Maskin, E. (2009), "Sequential Innovation, Patents and Imitation", *RAND Journal of Economics*, vol. 40(4), pages 611-635.

Bessen, J. and Meurer. M. *Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk*, Princeton University Press, 2008.

Boldrin, M. and Levine (2008), D. *Against Intellectual Monopoly*, Cambridge University Press, New York.

Choi, J. P. (2005), "Live and Let Live: A Tale of Weak Patents." *Journal of the European Economic Association*, 3(2/3), pp. 724-733.

Choi, J. P. (2009), "Patent Pools and Cross-Licensing in the Shadow of Patent Litigation." Hi-Stat Discussion Paper.

Department of Justice and Federal Trade Commission (1995), *Antitrust Guidelines for the Licensing of Intellectual Property*.

Dequiedt, V. and Versaevel, B. (2006), "Patent Pools and the Dynamic Incentives to R&D." Centre National de la Recherche Scientifique Working Paper, available at http://ssrn.com/abstract=988303.

Eswaran, M. and Gallini, N. (1996), "Patent Policy and the Direction of Technological Change", *RAND Journal of Economics*, Vol. 27, No. 4.

Fershtman, C. and Kamien, M. (1992), "Cross Licensing and Complementary Technologies", *International Journal of Industrial Organization"*, Vol. 10, pp. 329-348.

Gallini, N. (1984), "Deterrence by Market Sharing: A Strategic Incentive for Licensing", *American Economic Review*, Vol. 74, no. 5, pp. 931-941.

_____ (2002), "The Economics of Patents: Lessons from Recent U.S. Patent Reform" *Journal of Economic Perspectives*, 16, pp. 131-154.

Gallini, N. and Scotchmer, S. (2002), "Intellectual Property: When is it the Best Incentive System?" in *NBER Chapters: Innovation Policy and the Economy*, Volume 2, pages 51-78.

Galasso, A. and Schankerman, M. (2010), "Patent Thickets, Courts, and the Market for Innovation", *Rand Journal of Economics*, vol. 41 (3), pp, 472-503.

Gaulé P. (2006), "Towards Patent Pools in Biotechnology?" CDM Working Paper, CEMI Report 2006-010, École Polytechnique Fédérale de Lausanne.

Gilbert, R. (2004), "Antitrust for Patent Pools: A Century of Policy Evolution." *Stanford Technology Law Review*, 3.

_____(2009), "The Essentiality Test for Patent Pools", Competition Policy Centre Working Paper, University of California, Berkeley.

Gold, R., Piper, T., Morin, J.F., Durell, K., Carbone, J. and Henry, E. (2007), "Preliminary Legal Review of Proposed Medicines Patent Pool", Prepared by TIP for UNITAID.

Hall, B. and Ziedonis, R. H. (2001), "The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995." *RAND Journal of Economics*, 32(1), pp. 101-128.

Heller, M. and Eisenberg, R. (1998), "Can Patents Deter Innovation? The Anticommons in Biomedical Research", *Science* 1, 280: 698-701.

Kamien, M., Muller, E. and Zang, I. (1992), "Research Joint Ventures and R&D Cartels", *American Economic Review*, Vol. 82, No, 5, pp. 1293-1306.

Kim,S.-H. (2004),"Vertical Structure and Patent Pools." *Review of Industrial Organization*, 25, pp.231-250.

Jaffe, A. and Lerner, J. (2004), *Innovation and its Discontents: How our broken patent system is endangering innovation and progress, and what to do about it,* Princeton University Press.

Lampe, R. and Moser, P. (2010a), "Do Patent Pools Encourage Innovation? Evidence from the 19th Century Sewing Machine Industry", NBER Working Paper.

_____ (2010b), "Patent Pools and the Direction of Technical Change: Evidence from the 19th Century Sewing Machine Industry", Stanford Working Paper.

Lanjouw, J. and Lerner, J. (1998), "The Enforcement of Intellectual Property Rights:
A Survey of the Empirical Literature" Annales d'Economie et de Statistique, 49: 223-246.

_____ (2001), "Tilting the Table?The Use of Preliminary Injunctions", *Journal of Law and Economics*, University of Chicago Press, vol. 44, no. 2. pp. 573-603.

Lanjouw, J. and Schankerman, M. (2001), "Enforcement of Patent Rights in the United States," in Wesley Cohen and Stephen Merrill, eds., Patents in the Knowledge Economy (Washington D.C.: National Academies Press): 145-175.

Lemley, M. A. and Shapiro, C. "Probabilistic Patents." (2005), *Journal of Economic Perspectives*, 19(2), pp. 75-98.

Lerner, J.; Strojwas, M. and Tirole, J. (2007), "The Design of Patent Pools: The Determinants of Licensing Principles." *RAND Journal of Economics*, 38(3), pp. 610-625.

Lerner, J. and Tirole, J. (2004), "Efficient Patent Pools.", *American Economics Review*, 94(3), pp. 691-711; NBER Working Paper 9175, September 2002.

Merges, R. (1996), "Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations", *California Law Review,* vol. 84, no. 5, pp. 1293-1393.

Mullen, R. and Sicalides, B. "The Plane Lands on Patent Policy", *Antitrust Report,* Pepper Hamilton LLP, April 10, 2001.

Ordover, J., Saloner, G. and Salop, S. (1990), "Equilibrium Vertical Foreclosure", *American Economic Review,* 80, pp. 127-142.

Salop, S. and Scheffman, D. (1983), "Raising Rivals' Costs", *American Economic Review,* 73, pp. 267-271.

Shapiro, C. (2001), "Navigating the Patent Thicket: Cross-Licenses, Patent Pools and Standard Setting", in A. Jaffe, J. Lerner and S. Stern (eds.) *Innovation Policy and the Economy*, vol. 1, Cambridge MA, MIT Press, pp. 119-150.

Schiff, A. and Aoki, R. (2007), "Differentiated Standards and Patent Pools", Hitotsubashi University Working Paper.

Shapiro,C. (2003),"Antitrust Limits to Patent Settlements",*RAND Journal of Economics*,34(2), pp.391-411.

Tepperman, A. (2000), "Intellectual Property Rights in a Theory of the Firm" (2000), University of Toronto Working Paper.

USPTO (2000), "Patent Pools: A Solution to the Problem of Access to Biotechnology Patents?" United States Patents and Trademark Office.

Walsh, J. P., Arora, Cohen, W. (2003), "Effects of Research Tool Patents and Licensing on Biomedical Research", *Patents in a Knowledge-Based Economy,* National Academies Press.

Walsh, J. P., Cho, C., Cohen, W.M. (2005), "View from the Bench: Patents and Material Transfers", *Science*, Policy Forum, Science and Law, vol. 309, Sept. 23, pp. 2002-2003.

Whinston, M. (1990), "Tying, Foreclosure and Exclusion", *American Economic Review* 80:837-859.