Intellectual Property and Consortium Standard Patent Pools*

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In this paper, patent pools are examined in the context of a consortium standard. Although such pools of complementary technologies are approved by antitrust authorities, the actual implementation has proved to be problematic. The two possible obstacles are free riding and heterogeneous membership. Free riding on the standard gives incentive for firms to always become an outsider. Heterogeneous membership makes equal treatment of members and licensees [(part of reasonable and non-discriminatory (RAND) policy)] leading to unfair distribution of revenue.

Keywords: Patent pools, free rider problems, heterogeneity

The current practices of standard specification patent pools are examined in the context of consortium standards. A consortium standard is a collaborative venture of firms to promote a new technical standard. It can eventually be adopted by national or international standard setting bodies (a de jure standard) or become the de facto standard after winning the competition in the market with other possible standards. Since a majority of the recent standards involve proprietary standards, patent pools have become an essential feature of consortiums. Two interactions of a patent pool: one among members and another with users of the technology are examined. A list of recent successful consortiums is provided in Appendix 1.

A collaborative approach to standardization has become essential in the information and communication technology areas where speed of innovation and the world wide reach of the technologies have made compatibility and early establishment of a standard critical. Consortium standard is distinguished from a standard sponsored by a single firm in the following two respects. First, it involves multiple firms with different interests. Second, it adopts open licensing policy through its commitment to standard bodies such as International Telecommunication Union (ITU) and International Organization for Standardization (ISO).

Since such a consortium often involves collaboration among competitors, there is the question of how such collaboration can be designed to avoid becoming an anti-competitive device. The Cournot effect means it is socially beneficial to bundle complementary patents. Recognizing this fact, the US antitrust authority has stated that a patent pool of essential patents is not anticompetitive. A patent is essential to a standard if the standard is not possible to implement without the infringing patented technology. Thus essential patents for a particular standard are always complementary, implying it is socially desirable to have the set of patents form a pool and be licensed as a bundle.

Bundling patents has additional dynamic beneficial properties when they are part of a standard specification. Bundling improves not only consumer welfare but also the competitive position of a consortium standard relative to the standard controlled by a single firm. Second, the joint profit of firms is larger when the patents are bundled, since the unbundled prices exceed the profit maximizing price. Thus return from R&D investment will be greater when patents are bundled.

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## Appendix 1—Recent standard patent pools

<table>
<thead>
<tr>
<th>Name, Year</th>
<th>Admin.</th>
<th>Members</th>
<th>Licensing policy</th>
<th>Patents</th>
<th>Other info</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPEP 2, 1997</td>
<td>MPEP LA</td>
<td>Originally 13 firms, 1 firm that has an essential patent can participate, currently 22 firms, 1 univ.</td>
<td>1. The contract term is from 10 and a half to 15 and a half years. 2. For MPEP-2 decoding products, the royalty is US $4.00 for each decode unit. A royalty of US $4 per unit applies to Consumer Products having both encoding and decoding capabilities. (Both of which prior to Jan. 1, 2002, and $2.50 from Jan. 1, 2002.) etc. 3. Licensees have the right to renew for successive five-year periods for the life of any MPEP-2 Patent Portfolio Patent, subject to reasonable amendment of royalty terms and rates (not to exceed by more than 25%). 4. New Licensees and essential patents may be added at no additional cost.</td>
<td>Originally 27 patents, currently over 340.</td>
<td>1. Each firm can license independently. 2. The allocation of royalties depends on the share of patents contributed to the pool.</td>
</tr>
<tr>
<td>DVC(3C), 1998</td>
<td>Philips</td>
<td>Philips, Sony, Pioneer</td>
<td>1. The contract term is 10 years. 2. Commitment to royalty (royalties of 3.5% of the net selling price for each player sold, subject to a minimum fee of $77 per unit, which drops to $5 as of Jan. 1, 2000 and $3 per unit after 2002.) 3. A most favorable conditions clause. 4. An obligation for licensee to grant-back any essential patent on fair, reasonable and non-discriminatory terms.</td>
<td>115 patents for the manufacture of DVD players, 95 patents for the manufacture of the disc. Future essential patents.</td>
<td>1. Each firm can license independently. 2. The allocation of royalties is not a function of the number of patents contributed to the pool.</td>
</tr>
<tr>
<td>DVC(6C), 1998</td>
<td>Toshiba</td>
<td>Hitachi, Matsushita, Mitsubishi Electric, Time Warner, Toshiba, Victor Company of Japan</td>
<td>1. The contracts run until Dec. 31, 2002 and renew automatically for 5-year terms thereafter. 2. Commitment to royalty (royalties of $0.075 per DVD Disc and 4% of the net sales price of DVD players and DVD decoders, with a minimum royalty of $4.00 per player or decoder.) 3. A most-favored-nations clause. 4. An obligation for licensee to grant-back any essential patent on fair, reasonable and non-discriminatory terms.</td>
<td>All the present and future essential patents</td>
<td>1. Each firm can license independently. 2. The allocation of royalties depends on the share of patents contributed to the pool.</td>
</tr>
<tr>
<td>3G Platform</td>
<td>3G Patent Ltd* 19 firms (8 operators, 11 manufacturers)</td>
<td></td>
<td>1. Maximum Cumulative Royalty is 5% 2. Standard Royalty Rate per certified essential patent is 0.1% (However, the option to negotiate a bi-lateral agreement is available)</td>
<td>All the essential patents of the member firms</td>
<td>1. Members able to bi-pass and license independently with mutually agreeable terms. 2. The allocation of royalties depends on the share of patents contributed to the pool.</td>
</tr>
</tbody>
</table>

Efficient collaboration among the holders with complementary patents can increase consumers' welfare as well as R&D profitability of the firms. However, such collaboration does not necessarily occur. An outsider of the patent pool can emerge, who does not join in the pool and licenses an essential patent independently from the pool. Although such a licensor may be still subject to the RAND (reasonable and non-discriminatory) conditions when it has participated in the standard development, his licensing term is not bound by the licensing policy of the patent pool. In the worst case, a 'submarine' patent may emerge after the adoption of the standard. The outsider who suddenly surfaces can charge whatever the market bears, causing the hold-up problem in addition to double marginalization. Another possibility is that a patent pool for a single standard may split, so that a licensee must obtain licenses separately from two or more group of the patentees. In the case of the DVD patent pool, a firm must obtain at least two independent licenses, one each from the 3C group and the 6C group. Such breakdown of an integrated patent pool not only raises the total price to be paid by licensees but also reduces the joint profit of the patentees.

Two reasons for the expected or unexpected emergence of an outsider and the split of the patent pool are free rider problem and bargaining failure due to heterogeneous membership.

The Free Rider Problem

A firm that receives the licences of all the patents necessary to implement the technology for royalty $c_i$ for $i$-th patent will pay total of $\sum c_i$. The total demand for the licences will be $q(\sum c_i)$. Because the patents are essential, this is the demand for any one of the patents as well as the whole bundle if the patents are bundled. This means if a firm (an outsider) licenses a single patent for $c_1$ and price of a bundle (licensed by the pool) is $c_0$, demand for both the single patent and the bundle will be $q(c_0 + c_1)$ each. This is because the licensee must use both the single patent and the bundle (they are complements). The licensee must pay, $(c_0 + c_1)q(c_0 + c_1) = OR + PR$ where the outsider’s revenue is $OR = c_1q(c_0 + c_1)$ and patent pool’s revenue is $PR = c_0q(c_0 + c_1)$.

It is assumed that demand function $q(\cdot)$ is a decreasing function and that the demand is elastic. There are two sources of elasticity: (i) availability of substitute product and (ii) a substitute standard. Higher royalty will raise the price of the standard in addition to the reduction in demand of the final product. The latter occurs because the marginal cost has increased.

Assume that the outsider firm is a member of the pool and its patent is included in the bundle. Then pool’s revenue is $PR + OR$. The outsider (which is actually in the pool now) will get its share, $\theta$, of this revenue which is the proportion of patents it owns in the bundle. If $c_1 = \theta(c_0 + c_0)$, then there will be no difference between licensing as an outsider or as a member of a pool.

It is clear that as an outsider, the firm wants to set price higher than its correct proportion of the pool price, i.e., $c_1 \geq \theta(c_0 + c_0)$. Therefore, start from what is best for the pool. At this price, raising the price any higher will decrease revenue for all the other members as well as the firm in question. The pool price is set where the additional revenue from raising the price is exactly off set by the decline in revenue due to reduction of demand. The pool revenue is $OR + PR = (c_0 + c_1)q(c_0 + c_1)$. An outsider, however, only gets part of this, $OP$. An outsider can increase its revenue by raising the price it charges for its own patent only. This of course will reduce demand. However an outsider only takes into account its own revenue, $OR = c_1q(c_0 + c_1)$, and ignores reduction of $PR = c_0q(c_0 + c_1)$.

It is clear that an outsider will price its own patent so that $c_0 + c_1$ is higher than what it would be if its patent was part of the pool and priced as a bundle. As a result, total number of licenses will be less. The revenue for the pool will be reduced while outsider does better.

Thus, not joining the pool is profitable as a unilateral conduct. The disincentive for joining the pool increases as the number of complementary patents increases, since the profit share of a particular member of the patent pool declines while what it can collect as an outsider increases with the value of the standard.

The incentive to license independently as identified above is due to the free rider problem. Free rider
problem arises when access to the good is not excludable, that is, it is a public good. In the case of a standard specification patent pool, the public good is not the technology, since they are patented and access to them can be controlled. The public good is the demand for the standard. The outsider which has an essential patent related to the standard does not need permission from the other suppliers of the standard technologies to impose royalty on the users of the standard technology. If the outsider is also a user of the standard technology, his access to the demand can be controlled indirectly through licensing policy of the pool members. That is, the pool members can demand reciprocity in licensing to the outsider firm. It is important to note that the Department of Justice (DOJ) explicitly allows such clause as a device to support the viability of a patent pool against outsiders in its business review letter. However, such a clause is not effective at all on those outsiders who are specialized in licensing with respect to that standard.

There is a free-rider problem at the enforcement level also. Patent pools so far have not brought patent infringement suits as a pool. First of all, firms are afraid of anti-trust litigation if they cooperate to bring on a suit. Also the US Patent Law has specific qualifications necessary to initiate a patent suit. A patent pool may not satisfy the condition. Thus individual firms have initiated patent suits to protect their portion of the patent pool. Because litigation is costly, member firms want to wait for other members to initiate a suit, i.e., free ride on others to protect pool revenue.

**Heterogeneity**

In this section, the effect of firm heterogeneity on patent pool stability is analysed. There are two forms of heterogeneity: one among members and the other among licensees. Heterogeneity among patent pool members can lead to bargaining failure and thus break up of the pool. Heterogeneity among licensees can lead to RAND resulting in effectively unequal treatment of licensees. The two forms are related because basically there are three types of firms. First, there are research firms whose sole activity is research, acquisition of intellectual property and licensing them. At the other extreme are firms that only manufacture. They do not own any patents that are part of the standard. And the third type is the vertically integrated firms. They contribute patents to the patent pool, receive revenue and licence from it and manufacture products. Only two of the three types are patent pool members, and only two are licensees. Only the vertically integrated firm belongs to both types.

**Bargaining Failure**

The basic model of the following three types of firms that differ by vertical structure is considered: insider manufacturing V-firm (vertically integrated firm), only outsider manufacturing M-firm, and insider research only R-firm. Insider means a firm is in the patent pool, which collects specific royalty \( c \) from licensees. The patent pool has only 2 members, V and R firms, each of which has an essential patent. There are two licensees, V and M firms, which produce very different products: each firm produces as a monopolist in respective separate but identical the markets. This allows to focus only on significance of vertical structure of firms.\(^6\) When the (total) royalty is \( c \), M-firm always produces the monopoly output when marginal cost is \( c \) which is denoted as \( q_m(c) \). Thus M stands for ‘monopoly’ as well as manufacture (Figure 1).

![Figure 1 — Patent pool frontier](image)

**Patent Pool and Independent Licensing**

When there is a patent pool charging the bundle price, \( c \), V-firm chooses output \( q \) to maximize the sum of profit from production and its share (which is \( 1/2 \) since there are only two members, with equal number of patents) of royalty revenue. V-firm’s profit is
\[ P(q) - c \] \frac{q + q_M(c)}{2} c \quad \text{... (1)}

where \( P(q) \) is the inverse demand. Reorganizing, V-firm’s profit is equal to,
\[
\left( P(q) - \frac{c}{2} \right) q + \frac{q_M(c)}{2} c
\]

The V-firm produces as if the marginal cost were \( c/2 \), not \( c \). Because it gets royalty revenue as well as profit, it effectively gets a rebate of \( c/2 \) for each royalty payment \( c \) to the pool. Thus the maximum profit achieved with \( q = q_V(c) = q_M(c/2) \) can be denoted with \( \pi_V(c) \).

When V- and M-firms are producing optimally and \( c \) is given, R-firm’s profit is,
\[
\pi_R(c) = q_V(c) + q_M(c) c
\quad \text{... (2)}
\]

R-firm only has royalty revenue, which is the second term in V-firm's total profit. The pool sets royalty to maximize pool’s revenue, \( c(q_V(c) + q_M(c)) \). This also maximizes patent R-firm’s profit.

When firms license independently, V-firm chooses \( c_V \) and \( q \) simultaneously to maximize its profit. It is equivalent to maximizing:

\[
\pi_V = \left( P(q_M(c_R)) - c_R \right) q_M(c_R) + q_M(c_R + c_V) c_V
\]

and R-firm chooses \( c_R \) to maximize

\[
\pi_R = (q_V(c_R) + q_M(c_R + c_V)) c_R
\]

This is a non-cooperative game, where the firms choose royalty (firm’s strategy) simultaneously.

The following proposition characterizes the relationship between royalty set by a patent pool and royalties set independently.

**Proposition 1**

When \( c^* \), \( \pi_R^* \), \( \pi_V^* \) are the patent pool revenue maximizing royalty and profits, and \( \hat{c}_R \), \( \hat{c}_V \), \( \hat{\pi}_R \), \( \hat{\pi}_V \) are equilibrium royalties and profits when R- and V-firms set them independently, then

- Total royalty rate is higher, when firms license independently: \( \hat{c}_R + \hat{c}_V > c^* \).
- Total profit is lower, when firms license independently: \( \hat{\pi}_R + \hat{\pi}_V < \pi_R^* + \pi_V^* \).
- Integrated firm is worse off with independent licensing: \( \hat{\pi}_V < \pi_V^* \).

**What a Patent Pool Can and Cannot Achieve?**

It has been shown in the previous section that patent pools (where royalty is set to maximize pool revenue) yield total profit than if firms set royalty for their own patent independently.

Figure 1 shows the Patent Pool Frontier (PPF) in \( (\pi_R, \pi_V) \) space. Horizontal axis measure R-firm’s profit, \( \pi_R \), and the vertical axis measures \( \pi_V \). V-firms profit for different royalty rates. PPF is the plot of \( (\pi_R(c), \pi_V(c)) \) (each given by equations (1) and (2)) for different values of \( c \) between 0 and 1. The vertical intercept is when royalty rate is zero, \( c = 0 \). Since R-firm has profit from patent pool revenue, its profit is zero when \( c = 0 \). V-firm’s profit is highest when royalty rate is zero since, although there is no patent pool revenue, it makes no royalty payment. As royalty increases, V-firm’s profit decreases, while that of the R-firm increases. Pool revenue is maximized when \( c = c^* \) (characterized in the previous section) which is marked REV in Figure 1. R-firm’s profit is also maximized at REV since it is exactly \( 1/2 \) of pool revenue. Pool revenue decreases for any higher royalty rates for both firms. This is reflected in the positive slope of PPF.

The independent licensing point, where \( c = \hat{c} \), is marked IND. As observed in the previous section, R-firm is better off and V-firm better off with independent licensing compared to patent pool licensing. In Figure 1, this is reflected in the fact that the horizontal coordinate \( (\pi_R, \text{R-firm’s profit}) \) at IND is larger than at REV. V-firm is better-off at REV. That is, vertical coordinate \( (\pi_V, \text{V-firm’s profit}) \) at REV is larger than at IND. This is why IND lies southeast of REV.

IND lies outside the PPF. This means that it is not possible to achieve profits equal to independent licensing by patent pools, at least if revenue is distributed proportional to number of patents. It is not
T-firm’s output is denoted by \( q_T \), price by \( p_T \), and profit by \( \pi_T \). Vertical firm’s profit comes from both royalty and production:

\[
\pi_v = (p_v - c)q_v + \frac{cQ}{v + r},
\]

where \( Q = q_v + mq_M \) is the total output. M-firm has no royalty revenue:

\[
\pi_M = (p_M - c)q_M,
\]

while R-firm has only royalty revenue:

\[
\pi_R = \frac{cQ}{v + r}
\]

It is assumed that the same type of firms behave identically.

Perfect Competition in Manufacturing

When firms compete in prices (i.e., Bertrand competition\(^9\)), with homogeneous goods results in marginal cost pricing, equilibrium prices charged by V and M firms are:

\[
p_v = p_M = c
\]

Given marginal cost pricing in manufacturing, there is no mark up so that there is no inefficiency due to double marginalization when a patent pool is successful in bundling all complementary patents. In this case, the vertically integrated firm gets profit only from R&D, so that there are no divergence of interests between the vertically integrated firms and research firm,

\[
\pi_R = \frac{cQ}{v + r}, \quad \pi_v = \frac{cQ}{v + r}
\]
The pool chooses the royalty rate \( (c^*) \) to maximize \( Qc \) subject to competition with alternative standards. The RAND conditions require the pool to apply the rate \( c^* \) to all licensees. In the case of Bertrand competition in manufacturing, this non-discriminatory application of the royalty rate insures the efficient manufacturing. Only a firm with the lowest manufacturing cost serves the market, irrespective of whether it is an insider or an outsider. It also generates the maximum profit for R&D. Thus, non-discrimination is feasible and efficient.

**Local Monopoly**

Assuming that each firm serves its own market, i.e., each firm is a monopolist in its own market. Each firm chooses the profit maximization price, for a given royalty, \( c \). Thus, there is a positive mark up for a manufacturing firm and for a manufacturing operation of a vertically integrated firm. Any positive per use charge causes the problem of double marginalization.

In this case, non-discriminatory licensing does not ensure ex-post manufacturing efficiency. The perceived marginal cost is lower for an insider vertically integrated firm than the outsider manufacturing firm, since it perceives the gain from output expansion both from its sales of output and through royalty income:

\[
\frac{\partial \pi_v}{\partial q_v} = \frac{\partial}{\partial q_v} \left( P(q_v)q_v \right) - \left( 1 - \frac{1}{v + r} \right) c
\]

Thus, the non-discriminatory application of royalty in fact does not insure the efficient entry in manufacturing. The perceived marginal cost is lower for an insider vertically integrated firm than the outsider manufacturing firm, since it perceives the gain from output expansion both from its sales of output and through royalty income:

\[
\frac{\partial \pi_v}{\partial q_v} = -q_v + \frac{1}{v + r} \frac{\partial (Qc)}{\partial c} \]

several observations can be made. First, the outsider manufacturing firm wants the minimal price, since the second term does not exist. The insider research firm wants a higher price, since there is no first term. The vertically integrated firm is in the middle ground. It wants to balance its production profit and royalty revenue. The outcome would mainly depend on the negotiations between insider manufacturing firms, and insider research firms, as well as on competition with the other standards.

Secondly, higher royalty increases reward to R&D, but exacerbates the problem of double marginalization. The price of zero for technology is the most efficient price ex-post, but it gives no return on R&D by research firms. Thus, there is a clear trade-off between ex post efficiency and ex ante incentive. Given the dilution problem of R&D incentive identified above, there seems to be no good ground for a government to suppress the royalty even though it is high due to double marginalization. The solution to the trade-off cannot come from the government intervention in pricing. Instead, a lump-sum payment to the insider research firm may alleviate the above inefficiency. Buy-out of the IPR of the research firms would be an alternative, although such financing scheme may not be easily available for a technology coalition.

While discussing the effect on manufacturing efficiency of non-discriminatory licensing policy, why this might be beneficial in the context of dynamic competition was not discussed. Carlton and Gertner\(^{11}\) have argued that one advantage of an open source system to a proprietary system is that it makes it possible for anyone to make improvements. The system is able to improve or mutate according to needs more easily. Although a consortium standard depends on patented technology, its commitment to give access to anyone who requires at a ‘reasonable’ price allows outsiders to improve the technology as with the open system.

**Conclusion**

Two possible obstacles to a successful implementation of patent pools are identified: free riding and firm heterogeneity. Once the standard has been established, it is not possible to exclude a firm of an essential patent from accessing the demand for the standard (i.e., collecting royalty from the users of the patent). Patents can only be used to control access to the technologies implementing the standard. The non-cooperative outcomes of licensing are not achievable by transfer of rents by per patent split. This is because the royalty alone cannot increase patent revenue and
allocate rents among heterogeneous members at the same time. Thus, while it is easy to argue why a patent pool bundling complementary patents are socially desirable, the reality is that patent pools can be difficult to organize and to maintain.

The RAND licensing scheme and the way to allocate rents among pool members need to be changed to accommodate the heterogeneous membership. The heterogeneity of membership makes the ‘reasonable’ royalty policy more difficult to implement. This is because the relationship between royalty rate and revenue differs between research firms that only have patent revenue and vertically integrated firms that also have production profit as well as patent revenue. Charging sufficiently high royalty will transfer production profit from vertical firms to research firms in addition. Unfortunately, this transfer also reduces the size of the total pool revenue by compounding the harm of double-marginalization. Thus it is impossible to transfer enough revenue to make it profitable for a research firm to join a pool instead of licensing independently. This result suggests that there should be extra distribution to research firms to compensate for the lack of production profits. Requiring all members of the pool to be treated equally could be source of patent pool’s demise.

The current system of allocating pool rents according to patent numbers is also detrimental to innovation. Firms may significantly underinvest in quality of the standard since it is unable to obtain appropriate return on its R&D investment. Improving the dynamic incentive of the consortium standard will be important, since it may have to compete with a closed proprietary standard, which has a handicap in innovation, but has a clear advantage in appropriation.

It is very important for a competitive authority to deter the formation of pools. It would be detrimental to competition and innovation for a government to condition the approval of the pool on low royalty rate. Once the pool is judged to be a bundle of complementary patents, it should be free to set the royalty rate. On the other hand, a government intervention may be warranted to prevent the free riding on the pool by an outsider which surfaces after the standard is set.

References
3 Nalebuff Barry, Competing against bundles, Yale School of Management Working Paper, No ES-02, 2000
5 The above analysis assumed the Nash equilibrium of simultaneous pricing by the pool and the outsider. It is possible that the outsider moves first in price setting, since there is a first mover advantage
6 There is no market interaction between M and V firms: V-firm has no incentive to raise royalty to raise rival’s cost. See end of this section for details
7 V-firm’s royalty revenue comes only from the M-firm and does not include own output. So V-firm chooses output equal to the monopoly output when marginal cost is \( c_R \)
8 Remarks regarding the case of downstream oligopoly at end of previous section would apply here also
12 The licensing of certified essential patents will be undertaken by separate licensing companies (platform companies) which are specific to a particular radio access technology e.g. W-CDMA, cdma2000, TD-CDMA, etc. The members of the Platform Companies are the owners of certified essential patents
13 Platform company for the 3G systems based on the W-CDMA technology was formed in September 2003 (Platform WCDMA Limited or Platform WCDMA). Platform WCDMA will offer licenses under the W-CDMA Patent Licensing Programme which was launched officially on the 24 March 2004, but became effective on 1 January 2004