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Abstract

An economic problem for a client group for marketing advanced technology II: What is the mathematical model for the benefit/cost evaluations of the patent rights for high technology projects that could be used to generate scenarios on a personal computer.

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Abstract: ***The cause and effect of economic factors that result from competitors searching for market dominance or new product, service or intelectual property acqusition is an important arena that high technology companies seek justifiable and systematic economic basis. The development of such techniques for a high technology-sharing consortium is a current problem that our company Marketing Advanced Technology is finding to be currently challenging. This real life project is best stated as: How can high technology companies address the economic statement of innovation and the corresponding cause and effect upon profit and loss. This paper uses current economic application theory to establish a model of a simple case of only two companies that want the same patent rights to an innovation. The solution to this problem is presented by treating the granting of a patent license as a sale of an input in order to determine the incremental opportunity costs, which is what the client requested to be identified..***

Backgound: *This project request has resulted from the realization that protection of a company's patent rights [11] is an issue that is frequently tied up in courts [13] and is a difficult legal issue and frequently is fought with intensity and for long periods of time by all parties concerned. The realization by today's high technology companies that the time tied up in delaying the introduction of new products due to the issue of undetermined ownership combined with the lost sales and the legal expenses make* *seeking another alternative more appealing [3]. The results of court issued decisions are not as predictable as strategic planning and cash flow needs would dictate as necessary to guide successful business practise [1]. And, in addition, patent issue does not preclude the chance of infringement [8]. Very little needs to be changed to allow competition and "theft" of ideas is a possibility. The biggest problem is that the constant fast evolution of new products and services at an accelerated introduction rate with the according decrease in time between succeeding generations makes the difficulty of waiting for court derived decisions far too costly. So, today's innovation managers use the engineering management tool of computer modeling [10] based upon recent and solid economic application to produce scenarios that will give insight as to value of newly proposed products, services and intelectual properties. This paper uses this approach to identify a method of establishing opportunity costs for such products [7] so that companies can have a basis of value [5] to use as a negotiational beginning.*

Approach, methodology and support referenced from experts are included in the following paragraphs. Experts in economics begin their investigations by carefully listing the information and considering the interelationships of the problem. And then develop an initial and rather simplified version as a test case. The next stage is somewhat more formally presented in replication of events framework [9] or model. In a first round of description its structure can be assumed to resemble that of an "A" versus "B" dilemma game with the possible results and alternative paths recorded. For this problem, I started by using the following premise: If the members share information they all get higher pay-offs than if they all fail to do so [2]. To establish value, an additional condition was added: firm F1, will obtain a reward that is even higher if the other firm, F2, really shares while F1 succeeds in hiding its invention and concealing the fact that it is doing so [15]. This situation is illustrated in the payoff matrix of Table 1. in which the notation, as well as the discussion that follows directly after the matrix, are based on the work of Abreu, Milgrom, and Pearce (1991) [2].

Table 1 below shows that two available strategies for each player are Share (S) and Hide (H). π *is the return to each player if both players share, and excess profit, g, is earned by the firm that is able to exploit the other enterprise's sharing of its technology, but succeeds in hiding its own.*

Let us take π, *g, h, qand b, all to be strictly positive, with* $-b < -h$. *Then the symmetric pure strategy profile (S,S) clearly yields payoffs that dominate or Pareto dominate the other symmetric pure strategy profile* (H, H) . The mutual concealment strategy profile (H,H) is the unique *dominant strategy equilibrium, that is, either firm will do better by choosing H, given any fixed decision by the other enterprise.*

Table 1.

Payoff matrix 1

		Firm 2	
		S	*H*
Firm 1	*S*	π, π	$-b, \pi + g$
	H	$\pi + g, -b$	$-h, -h$

But if this is a repeated game that is played at t= 1, 2, ..., and the payoffs in the Matrix I are per period payoff values, then the payoff (π, π) *can be sustained in the long run. One equilibrium strategy pair in the repeated game that can in suitable circumstances yield the collusive payoff* (π, π) *is the trigger strategy profile.[2] This strategy entails the decision by both firms to play Share so long as the other does so, but to play Hide, forever after, once the other enterprise fails to share. If one firm, say i, expects to conceal in some period, call it the initial period, and it believes that the other firm has adopted the trigger strategy that will come into play after period 1, when i's concealment is discovered, then it will no longer* *earn* $\pi + g$*, nor even* π*, per period forever. Instead, taking* δ *as the pertinent discrete period discount factor, i can expect a stream of earnings whose net present value is*

$$NPV = (\pi + g) + (-h)\sum_{t=1}^{\infty}\delta^{t} = (\pi + g) + (-h)\delta/(1-\delta), \tag{1.1}$$

$$T = \delta + \delta^2 + \delta^3 \qquad -\delta T = -\delta^2 - \delta^3 \ldots \qquad T(1-\delta) = \delta \qquad T = \frac{\delta}{1-\delta}$$

okay

so that, taking this to be equivalent to the constant per period flow of earnings, E *for* $t = 0, 1, 2, \ldots,$ *will produce equation (1.2) below:*

$$NPV = E\sum_{t=0}^{\infty}\delta^{t} = E(1/(1-\delta)), \text{ or}$$

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$$T = 1 + \delta + \delta^2 \qquad -\delta T = -\delta - \delta^2 \ldots \qquad T(1-\delta) = 1 \qquad T = \frac{1}{1-\delta}$$

$$E = (\pi + g)(1-\delta) - h\delta. \tag{1.2}$$

The adoption of the trigger strategy will induce two profit-maximizing firms to act in a manner that yields the sharing equilibrium and renders it stable if $E < \pi$*, that is, if the earnings expectable from this course of action exceed those that can be expected from concealment of proprietary technical information. From potential defector point of view, this information is summarized in Table 2.*

Table 2.

Potential Defector Information

	Inclusion in Consortium	*Exclusion from Consortium*
Share	*0*	-----
Hide	*g*	*- h*

This applies where g represents a "one-shot" gain. However, as it stands, with no explicit role assigned to the other members of the consortium, the logic of the construct is the same as that found in dilemma game theory. It is only the presence of the other consortium members that changes the argument and carries it beyond the dilemma (a repeated-game story which asserts merely that the one shot gains from cheating does not exceed the future loss from punishment).

One drawback of the preceding construction is that it is not "negotiation proof" (refer to Farrel and Maskin[1989] and Pearce [1987 / 1990]). After a defection in the two player case, both firms receive low noncooperative payoffs in the punishment phase that follows. They could be tempted to promote their mutual interests by renegotiating to achieve a more cooperative mode of operation. But if that is anticipated, the entire incentive structure of the supposed equilibrium unravels. More sophisticated structures are needed to evade this problem. The references cited explore options.

However, in this setting, the issue has a nice resolution that rests on the presence of a multiplicity of other firms in the consortium. A defecting firm is punished upon detection (though this may occur only with a lag) simply by exclusion from the consortium. The special feature that characterizes this case is the fact that the nondefecting firms have no need to break up their profitable sharing arrangement. They can go on indefinitely, sharing their information, while the defector continues to suffer the consequences of exclusion. In contestable markets this argument can be strengthened further; for the place of the defecting firm can be taken over by a new entrant.

In short, this formal analysis lends some systematic support to an assertion, in the previous section, about sources of the stability of a technology sharing consortium. This is the argument that the likelihood of continued profitability of membership in a technology consortium even after defection of one or even *several of its members contributes stability to this form of association of a sort that a horizontal price cartel does not enjoy [14].*

Conclusion: *I have tried to set the ground work of this problem by choosing a simple case with two participants. Since the question is more involved, further research suggests a better model may be a dynamic Markov game [6] in which the state variable (the accumulation of each firm's technical information) increases during periods when sharing goes on. The other main oversimplification is that concealment of information is treated here as though it were perfectly or nearly perfectly observable, though it is in fact likely to be recognized by other firms only imperfectly and only after some delay. Exploration of these effects is supported by analysis of expert applications theory [2].*

Case Application: *Increasing and Decreasing Cost, Marginal vs. Average Cost Pricing, and the Role of Opportunity Costs.*

The economic literature has reiterated two pertinent propositions which together constitute the foundation of much of the discussion that follows. These propositions assert that: (1) subject to the well known qualifications, economic efficiency requires the price of each product (including a license giving the holder the right to employ an innovation) to be set equal to that item's marginal cost [3], and (2) the pertinent marginal cost must include all opportunity costs [4], [15] incurred by the supplier in providing the product. The term direct costs will refer to all costs that, from the point of view of the supplier firm, are not opportunity costs.

The licensing of an innovation would seem to incur negligible direct costs to the licenser. That is, as the public good attributes of information indicate, technology transfer may entail very little direct cost to the supplier. However, the opportunity costs may well be substantial. This is clearly true if a patent holder's *grant of the license to actual prospective rivals permits those rivels to take profitable business away from the patent holder [11]. It is equally true if the ensuing rivalry forces prices downward or if it adds materially to advertising and other outlays. Thus the marginal costs pertinent to the efficient pricing of a patent license may plausibly be expected to consist largely, perhaps even almost entirely, of the sort of opportunity costs that have just been described. These observations provide much of the logical basis of the discussion of efficient patent licensing fees.*

However, there is a subtle complication of rather substantial importance that does not seem to have been recognized in much of the literature. There are circumstances in which, while the total opportunity costs are substantial, they can be expected to be close to zero at the margin. The marginal opportunity cost of the sale or lease of some good or service can be positive if the item is limited in supply or entails some fixed capacity, so that the more the seller supplies to others, the less it has available for its own use. A firm that lets others use a bridge whose capacity was fully employed in transporting its own products will thereby incur an opportunity cost. But the public-good attributes of an innovation mean that the grant of a license to others does not run into any such capacity limitation. Indeed, even where the product in question has no public good attributes, its provision to others need not incur any marginal opportunity costs in the long run on account of capacity restrictions, if the supplier can add to capacity and is prepared to do so up to the point at which marginal profit yield of further additions to capacity is zero [12].

An opportunity cost can arise also if the recipient of a license or some other valuable asset can use it to take profitable business away from the supplier. But as noted earlier, as the innovative activity of business firms has become routinized, their investment in innovation, as in every other activity, may be expected to be carried to the point where every such activity yields zero economic profit at the margin, *and the opportunity cost of loss of the marginal unit of any product of one of its activities may be expected to disappear.*

This argument is not quite valid as it misses the nature of the pertinent margin, and the character of what appears to be most common pricing arrangement for a patent license. Such a license is usually granted in return for a fixed royalty payment per unit sold of the final product that uses the innovation in question. A license to use a high technology product or intellectual property may be negotiated for a payment of, say, 4 percent value of each such device manufactured and sold by the licensee.And if that price is set so low that the licensee is able to take away a high proportion of the sales of a similar product by the patent holder, more than just the zero profit marginal unit of its original sales volume is likely to be lost.. That is, a substantial opportunity cost may well be picked up by the licenser firm if it permits the licensee to sell still another unit of the product (the most literal meaning of marginal use of a license).

But there is yet another reason--scale economies--why the opportunity cost incurred in the licensing of a patent can often be expected to play a substantial role in the determination of an efficient price for use of that asset. In an output-producing activity that is characterized by declining average incremental cost [2] the market will, in equilibrium, assign the entire output to a single producer. because if production of the output were divided up among several enterprises, the total resources cost must be greater than if it is carried out exclusively by the most efficient of the candidate producers. On the production side, then, the efficiency issue is not how much of the total output should be produced by each participating firm (as in the interior solution that one expects in the diminishing returns case most often considered in the literature). Rather, the issue is, the firms can produce the entire output at lowest resources cost. The most efficient firm should be defined as the one that produces the entire output at minimin total incremental cost or, what amounts to the same thing, at lowest average incremental cost.[15] Thus, where production *of the particular commodity is characterized by scale economies, average incremental cost replaces marginal cost as the cost standard pertinent for efficiency in production.*

Also, efficiency in production requires, in the case product in question is characterized by declining average incremental cost (AIC), that price be set no lower than average incremental cost. Because if Firm A sets the priceof Y below its AIC (and presumably finances this output by cross-subsidy) it may preclude production by more efficient Firm B whose AIC for Y is less than A's but is above A's price (this assumes that B either has no source out of which to cross-subsidize the production of Y, as A does, or that B is unwilling to engage in cross-subsidization). The conclusion that an efficient price must in this case equal or exceed AIC means that an efficient price must then be higher than marginal ost because, where AIC declines with output, marginal cost must be less than AIC. In other words, the efficiency rules are modified, with AIC playing at least part of the role nornnally acted by marginal cost (MC) in the case of diminishing returns.[12]

What is the pertinence of this argument to the issue that is crucial to this project. Is it the role of opportunity cost in the determination of efficient price? In some circumstances, notably when opportunity cost is created by capacity limitations, that marginal opportunities cost can be driven to zero if the supplier of the facility at issue can expand its capacity to the point that enables him to use as much as he wants for his own purposes and to sell or lease to others as much of it as he desires. But in such a case, even though marginal opportunity cost will be zero (because capacity will be expanded by a profit-maximizing firm to the point where it gains nothing by adding another unit), it does not follow that the opportunity cost on inframarginal units of capacity will also be zero [2]. If inframarginal units do yield positive benefits to the owner when used for his own purposes, and if some substantial proportion of that capacity is nevertheless rented or sold to someone else, that transaction will entail a nonzero opportunity