Potential Competition and Contracting in Innovation

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Traditional analyses of patents commonly begin with a derived demand curve. The marginal revenue of this demand curve is then equated with some marginal cost curve, and the area between the two curves is considered as the private return to a patent.[1] The close resemblance of this solution with the monopoly pricing solution shapes the impression that patents and competition are incompatible. However, no attention in the literature has been paid to the way inventive activities are organized. This omission turns out to be crucial in affecting the logic, the conclusion, and the applicability of the traditional model in explaining real world behavior.

Consider a sample of the questions which this paper addresses: Why do patent licenses frequently include the granting of future patent rights? How are they enforced? Under what situations do we expect the practice to be more frequent? Why do patent licenses seldom specify the patent number, which seemingly is the most effective way to specify the subject matter licensed? What might explain the high turnover rate of inventors? With what kinds of industries and types of inventors do we expect the turnover rate to be higher? How does the turnover rate relate to licensing practices in the industries? What is the conceptual distinction between anticipated and unanticipated improvements? What was the rationale behind certain old patent laws? What problems of enforcement were faced? Why are certain restrictive stipulations imposed on patent licenses? Why is vertical integration so prevalent in the inventive industries? What are the distinctions among ordinary patent licenses, cross licenses, patent pools, and grant backs? Why are they formed? None of these questions can be answered by the traditional monopoly patent licensing model.

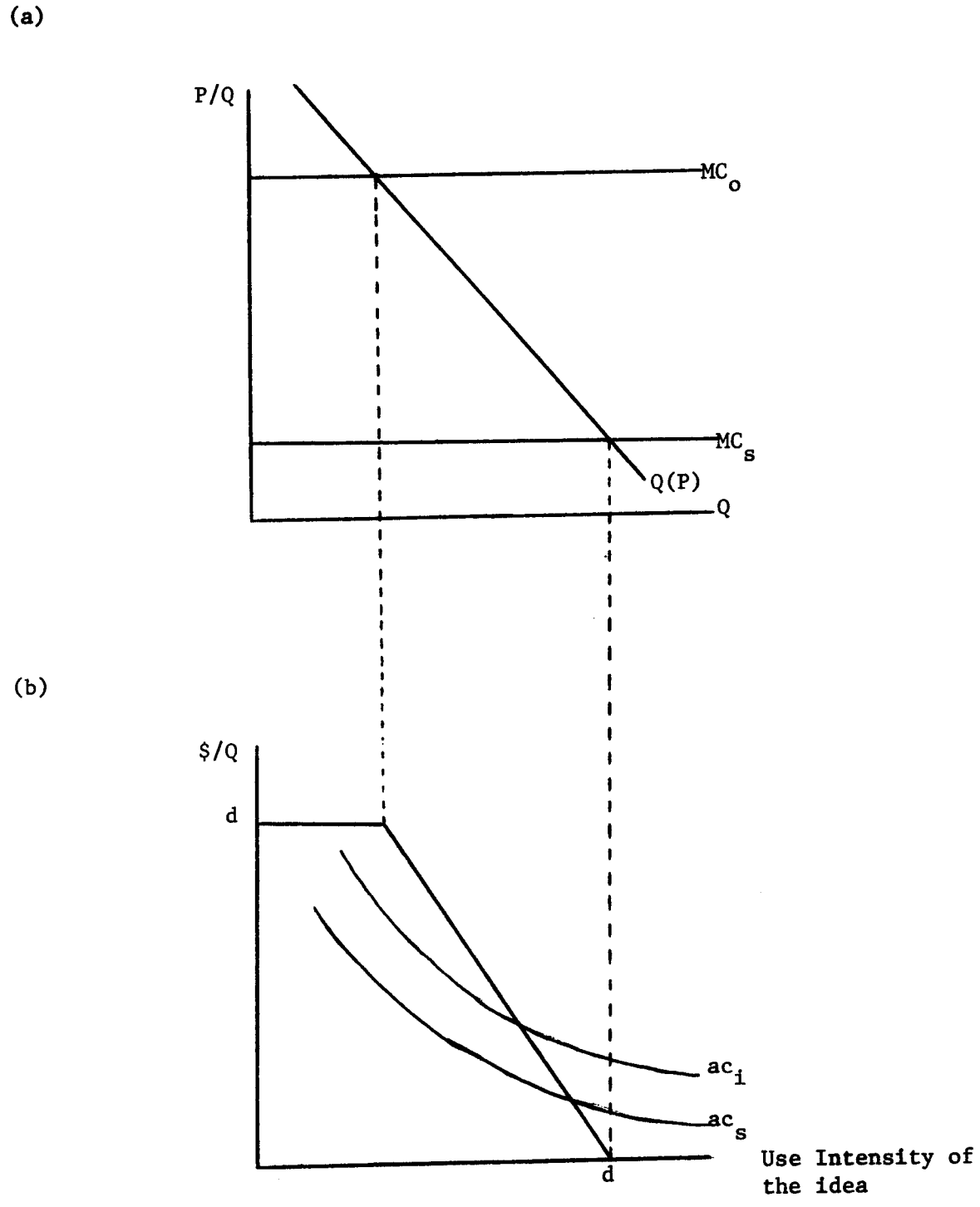
I. Prior Contracting for Innovation

The traditional model envisions the progress of an industry to start from inventors. Ideas first pop out from a random distribution; the useful ones will then be gradually adopted in the industry. In a world of zero transaction cost, however, the organization of inventive activities may follow a reversed sequence: consumer first demands cheaper and better products from manufacturers, who demand better and useful ideas from the inventors (or the research organization).[2] To fulfill these demands, inventors compete among themselves in supplying ideas to various manufacturers, who also compete among themselves in producing products incorporating the new ideas for the consumers. Viewed in terms of a consumer-manufacturer-inventor sequence, patent merely awards property rights to the output of an inventor; the incompatability of patent and competition is an illusion.

The unique feature of ideas is not the monopoly aspect, but rather the public good aspect; i.e., once an idea is invented, another identical or inferior idea will be valueless. The winner-takes-all property thus motivates propositions on premature innovations.[3] However, competition can take many different forms.[4] Potential competition for one, which received much attention in issues concerning public utility,[5] has been neglected in the area of innovations until recently. In essence, potential competition implies that the return to an innovation is not the monopoly rent traditionally described but is constrained by the cost of the next best inventor.[6]

The choice of the different forms of competition is not entirely arbitrary. Under the postulate of maximization, the least costly way to compete will always be chosen.[7] In view of the positive welfare consequences of potential competition, its applicability in innovation must be seriously considered.

Figure 1. Effective Demand for an Innovation



run. On the other hand, a manufacturer alert enough to select the "right" inventor cannot pocket the saving in royalty since competition among successful manufacturers necessarily implies that the gains are passed on to the consumers.[13] For this reason, manufacturers can be viewed as auctioneers hired by the consumers to search and compare competitive bids offered by potential inventors.

It will be naive to flatly reject potential competition in innovation on grounds that neither explicit inventor-consumer contracts nor explicit auction systems exist. Behind the determination of the terms in every contract (including patent licenses), there may be a bidding process among potential buyers and sellers. In fact, this is the underlying force in determining the price in every competitive market.[14] Even an automobile dealer, a grocery store owner, or any other so-called seller may be analytically indistinguishable from auctioneers for the goods he is selling. An explicit auction system is not a necessary condition in potential competition.

The sufficient condition for potential competition to be viable in innovation is prior contracting. Prior contract is a promise to innovate. Its output is, by definition, unknown before it emerges, and its production may be highly uncertain. Three central questions, therefore, immediately arise:

(1) How does prior contracting affect resource allocation in inventive activities?

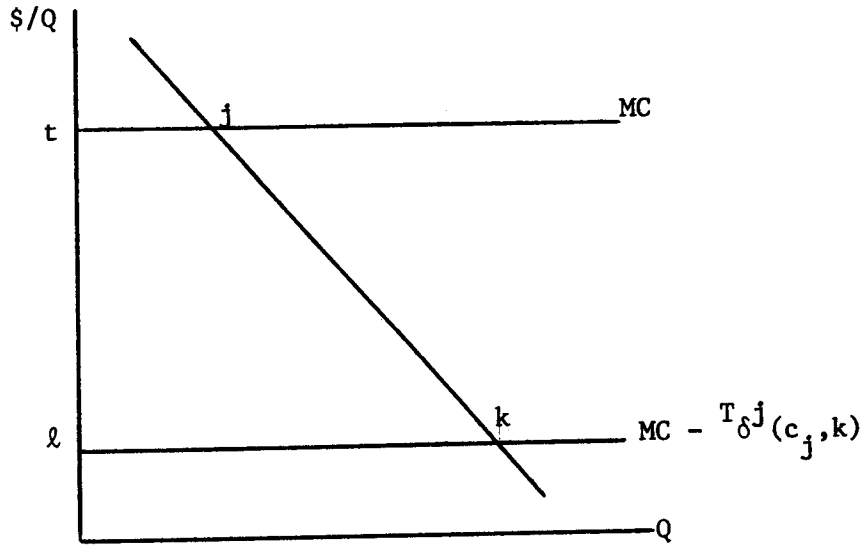
(2) What are the enforcement mechanisms for prior contracting?

(3) To what extent has the market been using it?

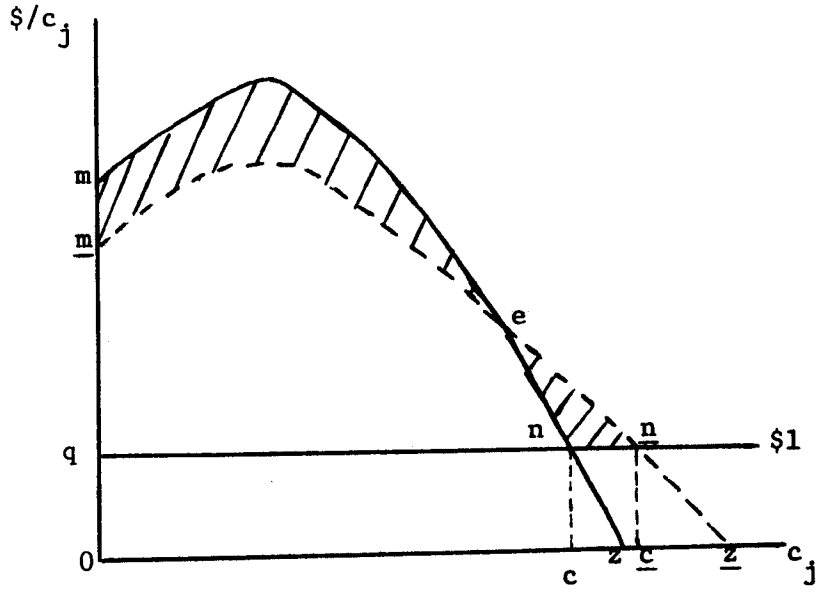
The theoretical analysis of resource allocation under prior contracts may be slightly more complicated than the case described above in which innovation is lumpy, but the underlying bidding process remains. The only conceptual complication added is that the manufacturers have to compare not only the royalties, but the "quality" of the research results to be anticipated from each inventor as well.

Figure 2. Resource Allocation in Innovations

(a)



(b)



once successful would tend to invent more. His incentive to repeat performance, therefore, provides the strongest enforcement mechanism of prior contracts.[18]

An action cannot be too costly if people are doing it. Casual observation suggests that prior contracting in innovation is quite common. Three predominant forms immediately come to mind: they are development contracts, employment contracts and patent licenses. Development contracts are used by research companies for contracting out part of their research projects. Explicit biddings are often observed. Thus, the applicability of potential competition is most intuitive.

Less obvious is the influence of potential competition in employment contracts. Typically, inventors are hired before their act of inventing, and they are paid according to their inputs (hours of research) rather than outputs (the value of their research results). Patents obtained in the course of the research are routinely turned over to the employer via assignments of patent rights.[19] The setting is perfect for potential competition. Thus, regardless of the "social" contribution of an inventor, we should expect his income to merely equal the expected cost (quality adjusted) of the next best invention.

Much attention in the literature has been paid to the enforcement of employment contracts. In many situations, inventors allegedly quit the firm supporting the original research and assign the patent to another firm instead.[20] The incentive behind such action, however, is not so much the inventors' desire to appropriate more return for <u>particular</u> patents as their inability to convince existing buyers that their lifetime abilities are higher than what they believe. Outright reneging on prior contracts will undoubtedly decrease the future reliability of an inventor. If his inventive potential remains the same as expected, he has little to gain by reneging. But if his inventive potential turns out

> extent that such patents relate or are applicable to the equipments herein referred to and to the uses and purposes for which said licenses are expressed as granted, and said licenses shall be for the term of this agreement.[23]

The "equipments referred to" in the granting clause includes "recording equipment," "reproducing equipment," and "sound record." In a different section of the contract, the definitions for each of these terms are specified. For example, in defining "recording equipment," the contract reads,

> Equipments adapted and intended for the recording of sounds and/or equipment adapted and intended to maintain a timed relation between the recording of sound and the taking or projection of motion pictures.

Not all patent licenses granting future patents extend to such a broad scope. By using appropriate words and phrases in the definition, contracting parties can widen or narrow the scope of the innovations in the package. For example, in a contract between a glass manufacturer and a research company in the glass container industry in the 1920's, the scope of the improvement seems narrower. In section 8 of a license Hartford-Empire (the research company) granted to Laurens Glass Works, Inc., (the manufacturer) it states:

> The word 'improvements' when used in this license and lease, shall be held to mean only (1) substitution of new parts for old parts of said leased machinery, or (2) changing old parts thereof, or (3) addition of new devices which are intended and adapted to become integral portions of such machinery, and not otherwise.[24]

The precommitted supply of improvements is the essence of prior contracting. This commitment can be detected from the research policy of Hartford-Empire. In a memorandum of the company, the development of these improvements was emphasized:

too long. The term and the area of research specified in a prior contract would then be adjusted to allow for such flexibility. The information risk, in particular, perhaps explains why some patents are contracted after their innovation. In selecting the right inventor in prior contracting, manufacturers probably want to see some headstart. A few patents and a crude machine may serve as the credential for an inventor. Such indicators may lower the information risk in prior contracting. Thus, on one hand, manufacturers do not want to contract with inventors too late because by doing so they will have to pay a higher royalty. On the other hand, manufacturers do not want to contract with the inventors too early because they suffer the higher risk of selecting the wrong inventor. Balancing the gain and the cost, there ought to be an optimal timing for prior contracting. One should anticipate the following phenomena: The more useful the anticipated innovation (thus a larger royalty if not prior contracted), the greater is the proportion of innovation prior contracted. The higher the information cost of selecting the right inventor, the lower is the proportion of innovation prior contracted. The more uncertain the innovation production function, the shorter is the term of the license and the narrower the area of research stipulated in prior contracting.

Regulation can be another deterrent to prior contracting. In many industries, the production of ideas is heavily subsidized. Government development contracts may require the research company to disclose all research results and assign patents back to the government.[27] A manufacturer would then have less incentive to prior contract since the innovation is in effect made nonexclusive.[28] In fact, one might argue that government subsidy can be an effective way to produce and to transact ideas if the tax and the research subsidy can be coordinated in accordance with consumer preferences.[29] Consumers pay for innovations

to make long term commitments in prior contracts. Complicated as the interaction may seem, potential testable implications may nevertheless be derived. One can look at the patents assigned as a percentage of the total patents in an industry, and correlate it with the percentage of future patents included in the manufacturers' patent licenses. The former is a measure of the extent of prior contracting at the inventors' level; the latter is a measure of the extent of prior contracting at the manufacturers' level. To the extent that the two variables are positively correlated, potential competition in innovation cannot be rejected.

the early periods as "wasteful."[34] Others may consider the subsequent improvements as trivial changes to strengthen existing patent positions.[35] However, if one recognizes the costliness of the accumulation process in innovations, early research is merely the forerunner to the latest improvements;[36] there are no a priori methods to weigh early vs. subsequent components of an innovation package.[37]

It is not the physical displacement of old machines by the new improved machine per se that creates the problem in the capturability of return in sequential innovations. If the whole innovation package has been prior contracted, the royalties initially negotiated would have taken such anticipated displacement into account. Even though the old machine is physically displaced, the innovative value of the old machine, in the sense that it serves as forerunner to the improved machine, would be included in the method of payment originally negotiated.[38] For example, royalty could be stipulated based on consumers' output rather than on the machine. Any improvement that reduces cost and thus increases output would automatically increase royalty when the improved version replaces the old. In the absence of enforcement problems in prior contracting, the return to early research remains capturable even though the old machines are physically displaced.

Nor is the displacement from another inventor's improved machine what causes the problem. If the improved machine of the other inventor utilized a completely different principle, it is a case of unanticipated displacement.[39] The old model is certainly bearing the windfall loss. But since the social ex ante return to the research incorporates the risk of obsolescence, private return equals social return ex ante, and there will be no resource misallocation. Even if the improvement is based on the crude model and a potential capturability

model a royalty from an anticipated improvement even though the physical form of the model is displaced. To what extent existing patent systems have provided this function is a crucial issue which must be examined.

Superficially, this function is apparently lacking. The ruling in an old patent case perhaps best describes the attitude of the court:

> Every invention may in a certain sense, embrace more or less discovery, for it must always include something that is new; but by no means follows that every discovery is an invention. It may be the soul of an invention, but it cannot be the subject of the exclusive control of the patentee, or of the patent law until it inhabits a body any more than a disembodied spirit can be subjected to the control of human laws.[44]

The soul and body analogy is most appropriate for the issue on hand. The ideas are the souls; the particular models by which ideas are manifested are the bodies. If the patent law only gives protection to the body, ideas will not be appropriately compensated.

Hopeless as the situation may seem, Professor Edmund Kitch has recently argued the contrary.[45] He cited many cases in which crude ideas had been given patent protection long before they were reduced to practice. He called this the "prospect" function of the patent system. My investigation into the early history of the patent laws not only supports the notion of "prospect function," it reveals the intended "scope" of a prospect. Section 2 in the Patent Act of 1793 states:

> Provided always, and be it further enacted, that any person who shall have discovered an improvement in the principle of any machine, or in the process of any composition of matter, which shall have been patented, and shall have obtained a patent for such improvement, he shall not be at liberty to make, use, or vend the original discovery, nor shall the first inventor be at liberty to use the

III. Private Remedies

Economic waste resulting from any divergence between private and social gain is intolerable in a framework of joint maximization. We expect private contractual arrangements to minimize the waste resulting from the divergence.[51] For at least two reasons private remedies may be superior to the direct enforcement of patent rights. First, the cost of identifying anticipated v. unanticipated improvement may be lower for people within the industry than for people outside the industry. The judges, the lawyers, or the economists do not usually have the talents to evaluate research outside their professions. The most effective way to invent varies among different industries. Laboratory experiments, feedback from machine maintenance, trial and error of crude models, seminars, lunchtime conversation and pipe-puffing in an isolated office all have relative values that can be more accurately evaluated by the members of industry. Thus, private research organizations in an industry can more efficiently tailor the degree of property right protection through contractual arrangements on their own. For example, if patent law protection in an industry is "excessive," patent rights can be abolished by the mutual granting of nonexclusive rights among members of the industry to use the patents at no charge. In fact, the automobile patent pool in 1915 may have this idea as the underlying purpose.[52] If patent law protection is ineffective, other contractual arrangements can in principle be adopted to strengthen protection in ideas.

The second support for private remedies is the lower enforcement cost of contract law as compared to patent law. Patent law protection relies heavily on the interpretation of patent claims which are often elusive.[53] Private contracting, on the other hand, has the freedom to adopt alternative enforcement mechanisms that are directly observable, resulting in easier detection

contract was for a period of eight years. For the right to use the glass feeder and its improvements, licensees had to pay a nonrefundable lump sum fee of $2,500, plus an annual minimum royalty of $1,500 regardless of contract cancellation. Section 17 of the license to Laurens Glass Works, Inc. specified the right and penalty of revocation:

> (Subject to certain unrelated conditions), no termination or revocation whatsoever of this license and lease under any Section hereof...affect or in any way discharge the liability of the Licensee hereunder, to pay and continue to pay to the Licensor, the minum royalty,_____, for and during the term of this license and lease..., nor shall any royalties paid by said Licensee be returned.[58]

One might suspect that the guarantee payment would encourage shirking on the delivery of improvements. However, as explained in previous sections, repetitive performance (on other devices if not on the same device) provides the incentive for the established research organization to fulfill its promises.[59] In addition, a royalty based on output could bolster such incentive. In the case of Hartford-Empire, the royalty was based on the weight of glass.

The agreement to refrain from patronizing the inferior inventors need not be explicit. The penalty (or reward) may take various different forms. Two possibilities are suggested: first, assuming that an inferior device produces inferior output, an agreement to refrain from the use of the inferior device could be stated in terms of some quality control of the products. Furthermore, to show good faith, the licensees might willingly agree to deposit earnest money, subject to rebate once the contractual terms are fulfilled. A system similar to this was adopted in Standard Sanitary Mfs. Co. v. United States, 226 U.S. 20 (1912). To what extent the technology in the enameling process

end products of the inventive effort rather than the effort itself.[65] A promise by the inferior inventor to refrain from competing with the superior inventor must be stated in terms of relinquishing his rights to license an innovation in the area held by the superior inventor.

Potential competition between the superior and the inferior inventors can be bilateral or unilateral. The former situation arises when A is inferior in B's project, and simultaneously B is inferior in A's project. The latter situation arises when A is inferior in B's project, but B's work is totally unrelated to A's. Depending on which situation prevails, the relinquishment of patent rights can be achieved in two different ways: (1) If potential competition is bilateral, the inferior inventor will grant an exclusive license to the superior inventor within the field in which the latter possesses comparative advantage; in return, the superior inventor will grant exclusive licenses to the inferior inventors within their fields of specialty--an arrangement that is commonly known as cross license.[66] (2) If potential competition is unilateral, all patents within a mutually defined area of inventions will be assigned to the superior inventor. The accumulation of these patents is commonly known as a patent pool.[67] Cross-licensing or pooling, the exchange of patent rights, is the heart of the arrangement.

Real world arrangements, however, are often complicated by additional price and quantity restrictions. Such complications arise because a contracting party in the real world often takes on dual roles as an inventor and as a user of the other party's innovations due to vertical integration in the inventive industries. Conceptually, each role would result in a different contract. The inventor's contract should involve nothing more than the exchange of patent rights; the manufacturer's contract, however, could be as complicated as any patent licenses ordinarily observed. If an autopsy of a cross-license is

Conclusion

Patent is not a monopoly. Within a framework of zero transaction cost, competition among manufacturers and inventors results in prior contracts in which the costs of the inferior inventors set upper bounds on the return to the patented innovations. With repetitive performance, inventors under prior contracts do not deliberately renege by nondelivery, and efficient allocation of resources in inventive activities results. A problem, however, arises when innovations emerge sequentially over time. To the extent that the patent protects only a physical form of the idea rather than the idea itself, inferior inventors can free-ride on improving the superior inventor's crude models, prompting the manufacturers to either cancel or revise the prior contracts they have with the original inventor. Consequently, returns to early research will be noncapturable. A "perfect" patent system presumably can eliminate the problem by having the improvement inventor compensate the original inventor. Although to some extent some evidence indicates that certain provisions in the patent laws have precisely this effect, perfect enforcement of the law may be very costly, and the capturability problem remains in many industries.

Real world contractual arrangements are rationalized as a means to solve the capturability problems under potential competition. There are basically two kinds of contracts: one is between inventors and manufacturers; the other is among inventors themselves. For the first class of contract, future patent grants are always included, and the term of the contract is usually quite long. This corresponds to the notion of prior contracting. Most ideas apparently are invented under a contract rather than something that pops out of the thin air. Although patents that are not prior contracted exist, they arise because of risk and regulations. Stipulations in a typical contract also illustrate the remedies

property rights protection given by the law may differ, but the underlying capturability problem and its solution may be very similar in nature. Third, the analysis may also be applied in the field of academics. University research policy, the frequency of co-authorship across different disclipines, customs on acknowledgement in scientific journals, all may be analyzed in some way by the framework described.

of Economics 81 (August 1967): 359-94. Baldwin, W.L. and B.L. Childs, "The Fast Second Rivalry in Research and Development," Southern Economic Journal 30 (July 1969): 18-24.

[5]Demsetz, Harold. "Why Regulate Utilities?" The Journal of Law and Economics 11 (April 1968): 55-66.

[6]Cheung, Steven N.S. and others. "Contractual Arrangements and the Capturability of Returns in Innovations: Report of a Pilot Investigation," (Mimeo., University of Washington, Institute for Economic Research, 1976).

[7]The notion of alternative forms of competition can be found in Alchian and Allen, Exchange and Production: Theory in Use, (Belmont, California: Wadsworth Publishing Co., 1969); that joint maximization is the criterion on the choice of different modes of competition is implicit in Steven Cheung, "A Theory of Price Control," Journal of Law and Economics 17 (April 1974): 53-72. The idea is basically derived from Ronald Coase, "The Problem of Social Cost," Journal of Law and Economics 3 (October 1960): 1-44. The choice of different forms of competition is analogous to the choice on initial allocation of rights. The analysis of the latter is in Richard A. Posner, Economic Analysis of Law, (Boston: Little, Brown & Co., 1977), 2nd ed., Part II.

[8]Harold Demsetz, "Why Regulate Utilities?", op. cit.

[9]The terms were used in a footnote in a later article by Harold Demsetz, "The Private Production of Public Goods," Journal of Law and Economics 19 (October 1972): 293-306.

[10]O.E. Williamson, "Franchise Bidding for Natural Monopolies--in General and With Respect to CATV," The Bell Journal of Economics 7 (Spring 1976): 73-104; V.P. Goldberg, "Regulation and Administered Contracts," The Bell Journal of Economics 7 (Autumn 1976): 426-8, idem., "Competitive Bidding and the Production of Precontract Information," The Bell Journal of Economics 8 (Spring

[18]This will be discussed in more detail in section III of this paper. It will suffice to point out here that there can conceptually be enforcement mechanisms. See Ben Klein and Keith Leffler, "The Role of Price in Guaranteeing Quality," Journal of Political Economy, forthcoming.

[19]See Frederik N. Neumeyer, The Employed Inventor in the United States: R & D Policies, Law and Practice (Cambridge, Massachusetts: MIT Press, 1971) chap. 2; Masanori Hashimoto, "The Employed Inventor" mimeo, University of Washington, 1977. Ben T. Yu, "The Economics of Patent Pool: the Capturing of Return to Basic Research," Doctoral Dissertation, University of Washington (1978), chap. 4.

[20]ibid. The experience in the electronic industries is most notorious. See John E. Tilton, International Diffusion of Technology: The Case of Semiconductors, (Washington, D.C.: The Brookings Institution, 1971).

[21]Of course, in actual testing of these propositions, other considerations must be taken into account. For example, industrial espionage, inferior inventors stealing ideas from superior inventors, legal rights structures between employer and employee, all these may affect employed inventors' turnover rate. Some discussions of these issues can be found in Neumeyer, op. cit., chap. 2.

[22]The observation is based on a preliminary investigation on licensing practices for the National Science Foundation. See Steven Cheung and others, op. cit. See also samples of contracts in U.S. Congress, House, Committee on Patents, Pooling of Patents, Hearing, 74th Congress on H.R. 4523, 1936; Exhibits in the Hearing before the Temporary National Economic Committee, Part 2.

[23]Recording license agreement between Electrical Research Products, Inc. and Hal Roach Studios, Inc., Pooling of Patents, ibid.

[24]Hearing before the Temporary National Economic Committee, Part 2, Exhibit 120. See also license from Hartford-Empire to Florida Glass Mfg. Co. (1935), T.N.E.C., Part 2, Exhibit 118.

monopoly rent may still exist. Manufacturers may still safeguard themselves by some prior arrangement with the research companies.

[29]See an excellent discussion of private vs. government financing of innovation in Kenneth Arrow, "Economic Welfare and the Allocation of Resources for Invention," op. cit.

[30]If the utilization of inventive results varies according to managerial capability, i.e. not only does the marginal cost of production decline, but the slope of the marginal cost changes as well, part of the return to innovation will be capitalized in a firm's asset. In that case, lump sum taxes would be levied on the manufacturers as well.

[31]A general discussion of this subject matter can be found in Raymond C. Nordhaus, Patent - Antitrust Law, 2nd ed. (Chicago: Jural Publishing Co., 1972), p. 309-328. The fact that the plaintiffs in some of these package patent cases were manufacturers (rather than government) apparently conflicts with the view presented here. For example, see Hazeltine Research v. Zenith Radio Corp., 388 F.2d 25 (C.A. 7, 1967). However, if one considers potential competition over time, a complication to be introduced in the next section, such observations may still be consistent with the general framework.

[32]For example, IBM was prohibited in 1956 from leasing its tabulating or electronic data processing machine for a period longer than one year; licenses on present and future patents must be granted to whoever requests them, royalty must be "reasonable" as determined by the court; infringement suits can be instituted only under limited circumstances. See United States v. IBM, 1956 CCH Trade Cas. par. 68,245 (S.D.N.Y. 1956) amended, Civil No. 72-344 (S.D.N.Y. 1963, 1970); see also an account of the early history of the computer industry in John T. Soma, The Computer Industry, (Lexington: D.C. Heath and Co., 1976), chap. 2.

[35]See Floyd L. Vaughan, The United States Patent System (Norman: University of Oklahoma Press, 1956); see also the discussion in F.M. Scherer, Industrial Market Structure and Economic Performance, (Chicago: Rand McNally & Co., 1971), pp. 391-2.

[36]Joseph Schumpeter touched on this briefly, "A new type of machine is in general but a link in a chain of improvements and may presently become obsolete." op. cit., p. 98. However, his reason appeared to rely on uncertainty rather than on the costliness of accumulation as argued here. It is only when uncertainty is introduced that Schumpeter's argument on "ex ante conservation of capital" makes sense. The crude model will not be wastefully scrapped if the durability of the model is built anticipating the emergence of the improvements. It is only when the improvement emerges much earlier than expected, and thus the crude model was made too durable, that we might observe the market to "stifle improvement in order to conserve existing capital values."

[37]F.M. Scherer called the view that weights early innovations more heavily "Usherian," ala A.P. Usher, A History of Mechanical Inventions, rev. ed., (Cambridge, MA: Harvard University Press, 1954). He called the view that weights later research more heavily "Schumpeterian," ala Joseph Schumpeter, The Theory of Economic Development, (Cambridge, MA: Harvard University Press, 1934). See Scherer's "Invention and Innovation in the Watt-Boulton Steam-Engine Venture," Technology and Culture 6 (Spring 1965): 165-6.

[38]It is socially efficient for this type of anticipated displaced machine to continue receiving royalty. In the absence of economic obsolescence, inventive effort successively reduces marginal production cost per period. These research efforts are cumulative, and the gain from each unit of effort is counted until infinity. Even though the crude model is displaced, its idea is still

[44]Morton v. N.Y. Eye Infirmary, 5 Blatch 116, 1862; 2 Fisher 320. The case was discussed in Alf K. Berle and L. Sprague de Camp, Inventions, Patents, and Their Management (Princeton, New Jersey: D. Van Nostrand Co., Inc., 1959) pp. 90-92. See also Alf K. Berle and L. Sprague de Camp, op. cit., chap. 5; Charles Rivise and A.D. Caesar, Patentability and Validity, (Charlottesville, VA: The Michie Co. Law Publishers, 1936), p. 52; Ben T. Yu, "The Economics of Patent Pools", op. cit., chap. 5.

[45]See Edmund W. Kitch, "The Nature and the Function of the Patent System," Journal of Law and Economics 20 (April 1978): 265-90. See also the discussion on similar issues in Cheung (1977), op. cit., and Ben T. Yu, op. cit.

[46]Feb. 21, 1973, c. 11, 1 Stat 318.

[47]Only extreme skeptics would doubt that railroad was an "unanticipated improvement" in transportation over stagecoaches, and that different models of pocket calculators were "unanticipated improvements" in the calculator industry. There are, however, many cases within a gray area in which people outside the industry (economists, lawyers, judges) have difficulty in classifying them either way.

[48]It would not matter what the scope of a prospect is in a world of zero transaction cost. Given costly contracting, however, the initital allocation of rights is indeed important; see Harold Demsetz, "Towards a Theory of Property Rights," 57 The American Economic Review 347 (1967). See also Richard A. Posner, op. cit.

[49]It is still a well-known rule in the courts that merely patenting the improvement cannot avoid the infringement of a basic patent; neither can the owner of a basic patent utilize the patented improvement. See the list of cases in United States Code Annotated, Title 35, chap. 28, section 271, note 78.

[50]Northwest Engineering Corporation v. Keystone Driller Co., 70 F.2d. 13.

Problem," Yale Law Journal 67 (November 1957): 19-36. For works on property rights, see Harold Demsetz, "The Exchange and Enforcement of Property Rights," Journal of Law and Economics 7 (October 1964): 11-26; Steven Cheung, "The Structure of a Contract and the Theory of a Non-exclusive Resource," Journal of Law and Economics 13 (April 1970): 49-70. For works on the theory of firms, see O.E. Williamson, Market and Hierarchies, (New York: The Free Press, 1975); H. Jensen and W. Meckling, "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure," Journal of Financial Economics 3 (October 1976): 305-60.

[56]Klein, et al, op. cit.; Klein and Leffler, op. cit.; Mayer and Thaler, "Sticky Wages and Implicit Contracts: A Transactional Approach." Economic Inquiry 17 (October 1979): 559-74. Hashimoto and Yu, "Specific Capital, Employment Contracts and Wage Rigidity," University of Washington, August 1979, Dis. Paper No. 79-23.

[57]Kitch has also mentioned the possibility of private contracting. However, he sees private contracting as a complement rather than an alternative to patent protection. "The Nature and Function of the Patent System," op. cit., p. 277 and p. 285.

[58]Similar clauses can also be found in the licenses Hartford-Empire granted to Northwestern Glass Co. (1933), to Florida Glass Mfg. Co. (1935). The latter was on the Miller Feeder rather than the Hartford Single Feeder. See T.N.E.C. Exhibits 118, 119, 120, Part II.

[59]Hartford-Empire is known to have engaged in many different types of research besides glass feeding techniques. See T.N.E.C. op. cit., Exhibit 125.

[60]The innovation in the case was an automatic dredger for enameling bath wares. The biggest advantage of the innovation was to provide an even layer of enamels on bath wares and thus make the wares more durable. Uneven enamel bath

[66]An example of this case can be found in the arrangement between AT&T and General Electric in the 1920's. AT&T was the superior inventor in communication systems; General Electric was the superior inventor in electric appliances. Although their researches were highly related, each was the inferior inventor in the other's field of research. A consent decree in 1932, however, changed the cross-license from exclusive to nonexclusive. See Laurence I. Wood, Patents and Antitrust Law, (Chicago: Commerce Clearing House, 1942), pp. 128-37. Other examples can be found in Hartford-Empire Co. v. United States, 323 U.S. 386 (1945); Standard Oil Co. (Indiana) v. United States, 283 U.S. 163 (1931).

[67]Examples are numerous. Notable ones are Standard Sanitary Mfg. vs. U.S., cited in the text; United Shoe Machinery Co. vs. United States, 258 U.S. 463 (1922); Ethyl Gasoline Corp. v. United States, 309 U.S. 436 (1940).

[68]The difficult question of the various price and quantity restrictions in patent licenses has not been examined in this paper. Some of these restrictions have been rationalized in the paper by Priest, op. cit., but the link between the exchange of rights aspect and the licensing aspect has not been made clear. Without any solid theory on this link, it seems odd that the court has traditionally taken a more stringent stand on interpreting restriction in patent combinations. See the observations reported in Cheung, "Antitrust and Patent Combinations: Some Economic Implications of Section One of the Sherman Act." Mimeo. University of Washington.

[69]This is my view on certain aspects of the patent pool in the glass container industry in the 1920's. Hartford-Empire Co. v. United States, op. cit.. Before 1912, glass container manufacturing technique had been limited to what was known as the Owens suction method. Between 1912 and 1924, considerable research was done by Hartford on a method known as the gob-fed. For certain types of glassware, gob-fed was certainly superior to suction. The cross license between Hartford

Bibliography

Alchian, Armen and Allen, William, Exchange and Production: Theory in Use, 1st ed., (Belmont, CA: Wadsworth Publishing Co., Inc., 1969)

Alchian, Armen and Demsetz, Harold, "Production, Information Costs, and Economic Organization," American Economic Review 62 (December 1972): 777-95

Arrow, Kenneth J., "Economic Welfare and the Allocation of Resources for Invention," NBER, The Rate and Direction of Inventive Activity (Princeton: Princeton University Press, 1962)

Baldwin, W.L. and Childs, G.L., "The Fast Second Rivalry in Research and Development," Southern Economic Journal 36 (July 1969): 18-24

Barzel, Yoram, "Optimal Timing of Innovations," Review of Economics and Statistics 50 (August 1968): 348-55

Barzel, Yoram, "An Alternative Approach to the Analysis of Taxation," Journal of Political Economy 84 (1976): 1177

Beach, R.W., "Patent Cross-Licensing Agreements and Methods of their Administration," Journal of the Patent Office Society 19 (August 1937): 578-95, (September 1937): 646-67

Beck, Roger, "Patents, Property Rights and Social Welfare: Search for a Restricted Optimum," Southern Economic Journal 43 (October 1976): 1050-54

Berle, Alf K. and Sprague de Camp, L., Inventions, Patents, and Their Management (Princeton, NJ: D. Van Nostrand Co., Inc., 1959)

Bishop, Robert L., "The Glass Container Industry," in The Structure of American Industry, ed. Walter Adams (New York: Macmillan, 1950)

Bowman, Ward S. Jr., "Tying Arrangements and the Leverage Problem," Yale Law Journal 67 (November 1957): 19-36

Bowman, Ward S. Jr., Patent and Antitrust Law (Chicago: University of Chicago Press, 1973)

Epstein, Ralph C., The Automobile Industry (1928)

Goldberg, V.P., "Regulation and Administered Contracts," The Bell Journal of Economics 7 (Autumn 1976): 426-48

Goldberg, V.P., "Competitive Bidding and the Production of Precontract Information," The Bell Journal of Economics 8 (Spring 1977): 250-61

Hashimoto, Masanori, "The Employed Inventors," (mimeo, University of Washington, Institute of Economic Research, 1977)

Hashimoto, Masanori and Yu, Ben T., "Specific Capital, Employment Contracts and Wage Rigidity," University of Washington, August 1979, discussion paper No. 79-23

Hirshleifer, Jack, "The Private and Social Value of Information and Reward to Inventive Activity," American Economic Review 61 (September 1971): 561-74

Hu, Sheng Cheng, "On the Incentive to Invent: A Clarificatory Note," Journal of Law and Economics 16 (April 1973): 169-78

Jensen, H. and Meckling, W., "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure," Journal of Financial Economics 3 (October 1976): 305-60.

Kamien, Morton I. and Schwartz, Nancy L., "Market Structure, Elasticity of Demand and Incentive to Invent," Journal of Law and Economics 13 (April 1970): 241-52

Kitch, Edmond, "The Nature and Function of the Patent System," Journal of Law and Economics 20 (April 1978): 265-90

Klein, B., Crawford, R. and Alchian, A., "Vertical Integration, Appropriable Rents and the Competitive Contracting Process," Journal of Law and Economics 21 (October 1978): 297-326

Klein, Ben and Leffler, Keith, "The Role of Price in Guaranteeing Quality," Journal of Political Economy, forthcoming

Schmooker, Jacob, Invention and Economic Growth (Cambridge: Harvard University Press, 1966)

Schumpeter, Joseph A., The Theory of Economic Development (Cambridge: Harvard University Press, 1934)

Schumpeter, Joseph A., Capitalism, Socialism and Democracy, 3rd ed. (New York: Harper & Brothers, 1947)

Schussel, George, "IBM vs. Remrand," Datamation 74 (May and June 1965): 10

Sharpe, William, The Economics of Computers (New York: Columbia University Press, 1969)

Soma, John T., The Computer Industry (Lexington, MA: D.C. Health & Co., 1976)

Thompson, Earl, "The Perfectly Competitive Production of Collective Goods," The Review of Economics and Statistics 50 (February 1968): 1-12

Thompson, Earl, "Competition and Cooperation in the Private Marketing of Collective Goods," UCLA discussion paper

Tilton, John E., International Diffusion of Technology: The Case of Semiconductors (Washington, DC: The Brookings Institution, 1971)

United States Code Annotated, Title 35 (St. Paul, MN: West Publishing Co., 1954)

U.S., Congress, House, Committee on Patents, Pooling of Patents, Hearing, 74th Congress on H.R. 4523, 1936

U.S. Congress, Temporary National Economic Committee Hearing (1939), Part 2-3

Usher, A.P., A History of Mechanical Inventions, rev. ed. (Cambridge, MA: Harvard University Press, 1954)

Vaughan, Floyd, Economics of the Patent System (New York: Macmillan, 1925)

Williamson, O.E., Markets and Hierarchies (New York: The Free Press, 1975)