

A CONTRACTUAL REMEDY TO PREMATURE INNOVATION:  
THE VERTICAL INTEGRATION OF BRAND-NAME SPECIFIC RESEARCH

by

Ben T. Yu

Working Paper #305

University of California, Los Angeles

Department of Economics

August 1983

A CONTRACTUAL REMEDY TO PREMATURE INNOVATION:  
THE VERTICAL INTEGRATION OF BRAND-NAME SPECIFIC RESEARCH

Ben T. Yu\*

University of California, Los Angeles

It is a well-known proposition in the economics of innovation that fully enforceable patent rights would lead to premature innovations. Initially suggested by Barzel (1968), the proposition has been examined and modified in numerous subsequent studies (C. Kamien and Schwartz (1972), Loury (1979), Dasgupta and Stiglitz (1980), and Lee and Wilde (1980)). Such studies imposed additional assumptions of technological and economic uncertainties as well as game-theoretical strategies, but their conclusions uniformly supported Barzel's result in situations involving large numbers of inventors.

The result of premature innovation is a little strange, to say the least. If patents are viewed as grants to properties (ideas) rather than grants to monopolies (see Wood (1942) and Bowman (1973)), patent rights on ideas should merely facilitate voluntary exchanges in the same way that private rights on any property are designed to facilitate, and there appears no a priori reason to expect the reward of private property in general would lead to efficient results, while the reward of private property for ideas would be inefficient. This conjecture, perhaps, was the main motivation behind the study by Kitch (1977), who argued that even if premature innovation result holds, the patent system itself can be (and has been) designed in such a way to mitigate such occurrence. He called that the "prospect function" of the patent system.

The starting point of this study shares the same motivation as Kitch's but by adopting a different approach. The central question we are after is the following: Is there any private contractual mechanism that can discourage

premature innovation even in the absence of legal mechanisms as suggested by Kitch? In a trivial sense, the answer must necessarily be a yes. Invoking the Coase theorem in the context of zero transaction cost, one can argue that competing inventors could either explicitly or implicitly specify the optimal timing of innovation through a collusive agreement. However, this answer is not entirely interesting, both because contracting with a large number of potential inventors would be prohibitively costly, and more importantly, because collusive agreements are basically inconsistent with the notion of competition. In other words, the solution of collusive agreement may indeed resolve the premature innovation problem, but it does not deny the alleged proposition that a free market competitive environment would lead to premature innovation.

This paper examines contractual remedies of premature innovation that are consistent with the notion of competition. Our bench mark case will be the conventional rushing model, the particular version of the model will be that of Dasgupta and Stiglitz (1980). We will first demonstrate that it is in the self-interest of the consumer, the manufacturers, as well as the inventors to diverge independently from the rushing model. We emphasize that the particular form of contract leading to the divergence requires exclusive commitments on the part of the manufacturers to the innovative results of the winning inventor. The condition leading to the stability of prior commitment of manufacturers will be identified.

Second, we hypothesize that vertical integration of inventors with the production facilities of the manufacturers is a form of prior commitment to discourage premature innovation. The idea partially arose from the casual observation that many research organizations would listen only to in-house inventors (Hamberg, 1963), and that research activities in such organizations

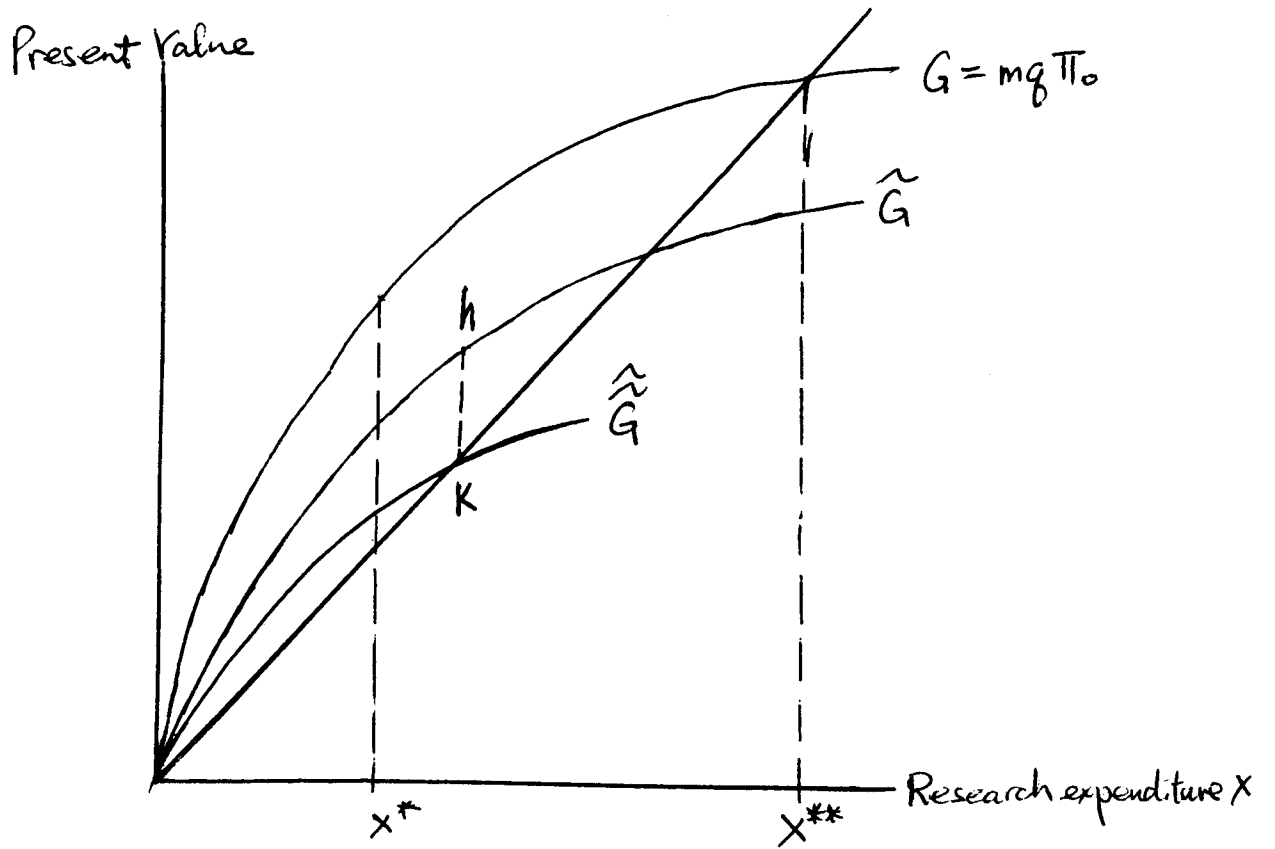
are specific to a particular operation rather than methods amenable to be concurrently utilized by all firms in the industry. The alleged low frequency of patent licensing practices (Wilson (1977); Telser, this issue) and the even distribution of R&D spending in a typical R&D intensive industry such as pharmaceutical industry (Schwartzman, 1976) similarly provide the motivation for this study.

### The Problem and the Remedy

The argument for premature innovation goes somewhat as follows: Suppose there is an expected gain of innovation,  $G$ , whose date of introduction  $T(x)$  is a function of the research effort chosen by an inventor. The present value of the innovation project is thus  $Ge^{-rT(x)}$ , where  $r$  is the rate of interest. The inventor wants to maximize net expected gain by choosing a research effort that equate the marginal increase in present value of the project with the marginal cost of research, i.e. chooses  $x$  so that  $-rT'Ge^{-rT(x)} = 1$ . However, under competition, he must expend  $x$  so that  $Ge^{-rT(x)} = x$ .

The situation can be represented in Figure 1. The concave curve  $GG$  represents the expected present value of the innovation as a function of the research expenditure. The  $45^\circ$  line represents the cost of research. The optimal research expenditure,  $x^*$ , is indicated by the point where the slopes of the two lines are equal, and the net return (or rent) to the innovation is measured by the difference between the two curves. The timing of the innovation,  $T(x^*)$ , resulting from that level research is considered as "optimal." Premature innovation arises because competing inventors recognize the existence of rent to the optimal innovation, and since a fully enforceable patent awards the rent to the first inventor who obtains the patent, each

FIGURE 1



inventor would choose a research level slightly greater than what his competitors will choose. With identical inventors, the equilibrium under this competitive pressure will result in excessive research expenditure,  $x^{**}$ , and the rent to the innovation will be totally dissipated.<sup>1</sup>

The contractual remedy to the dissipation problem in this paper hinges on a decomposition of  $G$ . For a cost-reducing innovation, this gain of innovation can be estimated by the area underneath the product demand as bounded by the old and the new cost curves (see Figure 2). For a perfectly competitive output industry, the cost curve is the locus of points joining the minimum average costs of the producing firms (i.e., manufacturers) in that industry. Thus,  $G$  can be viewed as the maximum royalty an inventor can obtain by charging each of these manufacturers. In other words,

$$G = mq\pi_0 \quad (1)$$

where  $m$  is the number of manufacturers,  $q$  is the minimum efficient size of the manufacturer, and  $\pi_0$  is the difference in the average costs of manufacturing and marketing before and after the innovation.

Consider an offer by an inventor to one or more of the manufacturers of the following form: I would give you a low royalty rate  $\pi_t$  less than  $\pi_0$  if you would agree to adopt exclusively my innovative results.

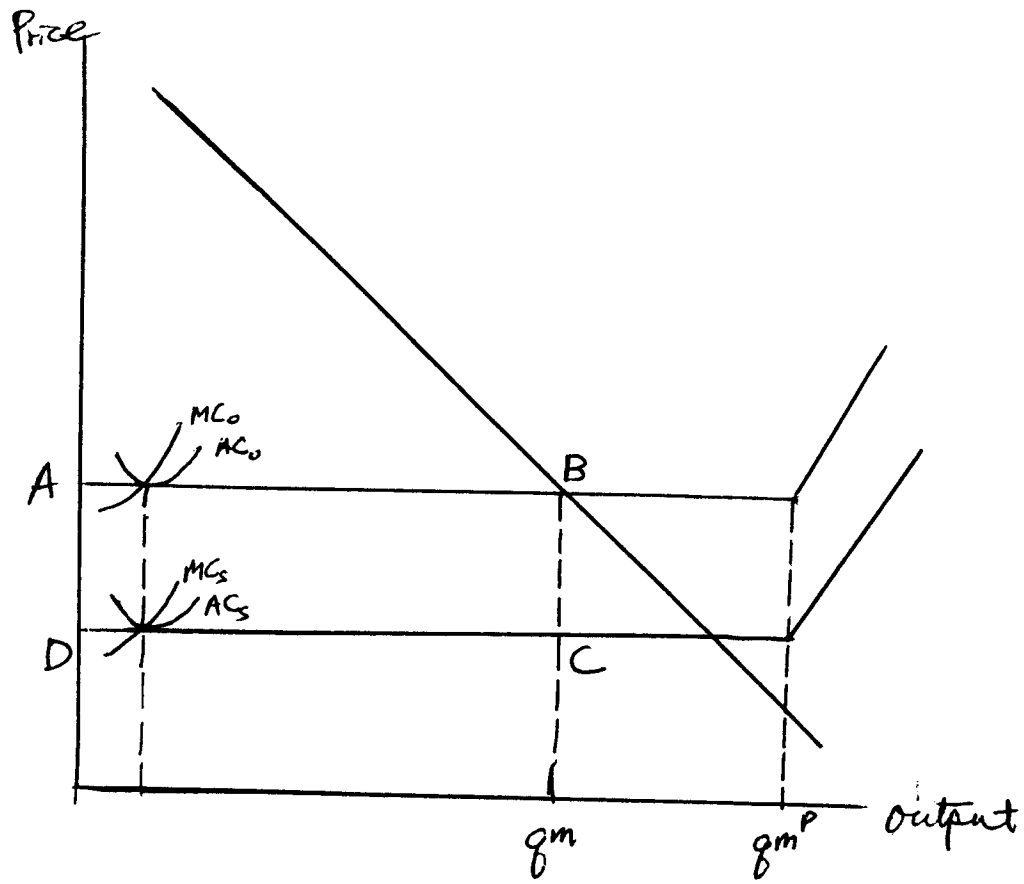
What is the gain to the inventor of making such a request? If  $m^c$  manufacturers sign up with him, his gain of innovation will be

$$\tilde{G} = [m^c\pi_t + (m-m^c)\pi_0]q \quad (2)$$

which will necessarily be lower than  $G$  in equation (1), since  $\pi_t < \pi_0$ . However, his competitor can now only capture the rest of the production and marketing facilities. If there are  $m^p$  of such potential facilities around, the expected gain of his competitor will be

$$\tilde{\tilde{G}} = [(m-m^c)\pi_0 + \min(m^c, m^p-m)\pi_0]q \quad (3)$$

FIGURE 2



Two cases are worth considering: first, if  $m^c < m^p - m$ ,

$$\tilde{G} = [(m-m^c)\pi_0 + m^c\pi_0]q = m\pi_0q > \tilde{G}$$

i.e. the competitor's gain will be higher than the gain to the inventor making the offer, and royalty cutting will not be a wealth maximizing strategy.

However, consider the second case, i.e.  $m^c > m^p - m$ ,

$$\tilde{G} = [(m-m^c)\pi_0 + (m^p-m)\pi_0]q.$$

Thus,  $\tilde{G} < \tilde{G}$  if  $(m^p-m^c)\pi_0 < m^c\pi_t + (m-m^c)\pi_0$  i.e.  $\frac{m^c}{m^p-m} > \frac{\pi_0}{\pi_t}$ . That is, if the reduction in royalty rate induces a sufficiently large number committed manufacturers relative to potential production and marketing facilities, the gain of a competing inventor would be lower than the gain of the royalty cutting inventor. In terms of Figure 1, two ex-ante identical inventors would no longer face the same gain curves  $GG$ . The royalty cutting inventor will have  $\tilde{G}\tilde{G}$  and a passive inventor will have  $\tilde{\tilde{G}}\tilde{\tilde{G}}$ . The result of this discrepancy in the gain curves implies that the royalty cutting inventor does not have to expend as much research expenditure as before. In fact, he can obtain a quasi-rent equal to  $hk$  as drawn in Figure 1 via royalty cutting.

What is the incentive on the part of a manufacturer in accepting the offer? A manufacturer also anticipates a quasi-rent because if he signs up with an inventor while his competitors do not, his cost curve including the reduced royalty would be lower than that of his competitors who must pay the maximum royalty as requested by the winning inventor. Furthermore, if he does not sign up with a successful inventor while his competitors do, the price of the product will be lowered and he will suffer a loss on specific assets as a result. Thus, it is the gain of getting ahead of other manufacturers and the fear of getting left behind that would induce a manufacturer to independently sign up with an inventor.



It is also clear that the consumer will not be worse-off if all inventors and manufacturers adopt the contract as described. The price of the product is likely to fall (depending on the equilibrium number of committed manufacturers). In other words, part of the  $G$  in the premature innovation model will be transformed into consumer surplus.<sup>2</sup>

What we have just shown is a "short-run" Pareto improvement over the conventional rushing result. The contract facilitating the improvement requires only exclusive commitments on the part of manufacturers. These commitments are not necessarily costless; and in the real world, mistakes can happen. Two particular forms of such commitments that may reduce mistakes are vertical integration of R&D with manufacturers and brand-name advertising: It is often reported that many manufacturers with research staffs would listen only to in-house inventors (Hamberg, 1963). Research activities in an organization are often specific to a particular operation rather than methods amenable to be concurrently utilized by all firms in the industry. Also, brand-name advertising is often associated with R&D intensive industries. It is not entirely clear what information, if any, this advertising is providing. The daily activity of a detailman in a pharmaceutical industry, for example, may involve socializing with physicians rather than providing information on particular drugs (which are readily available in printed literature and medical journals). Are they advertising only the company's existing product line or their company's expertise in a certain field?

The nature of advertising has been studied recently by many economists.<sup>3</sup> Some allege that it provides useful information while others believe it will only redistribute income and create a barrier to entry.<sup>4</sup> In terms of the formulation we have described, a barrier to entry is equivalent to a decrease in potential manufacturing and marketing facilities, i.e.,  $m^P$

is lowered. Viewed in terms of a static environment, this activity may indeed be wasteful. However, if viewed in terms of a dynamic environment where premature innovation is a potential problem, such brand-name advertising and commitment on research strategy may be a contractual remedy to resolve premature innovations.

#### Rent Dissipation vs. Nonexclusive Right to Innovate

What are the unique features in our solution that make it different from other rent dissipation phenomena such as a common fishery or an Alaska land rush? In all of these dissipation problems, the incentive to minimize dissipation exists as a cooperative outcome, but the contractual method by which dissipation is minimized can vary depending on the physical attributes of the problem involved.<sup>5</sup> The particular physical attributes that generate our arguments are (i) The contemplated productive activities are purely for exchange purposes rather than for direct consumption (e.g., let's say the fish is only used for cannery or sushi bars, and the land has economic value only because of the crude oil underground). (ii) The incentive structure is such that only one out of many competing agents will be given a prize, i.e., winner takes all (e.g., one fish or one parcel of land). (iii) The magnitude of the prize is controlled by a group of finite, independent, but competing producers of end products. The ability to control implies both an imperfect entry condition in producing the end products of the nonexclusive resource as well as rising marginal costs of these competing producers (e.g., the preparation of sashimi -- raw fish as end products -- has severe preservation problems which require brand-name investment; also, individual sushi bars or oil refineries cannot handle additional supplies of raw fish or crude oil without changing prices). In the presence of these conditions, private contractual

remedy in the form of vertical integration would be a feasible alternative to deter dissipation.<sup>6</sup>

In reality, vertical integration is only one possible solution of a more general optimization problem, whose domain includes political as well as other private remedies. A political solution would call for legislative actions to grant an explicit right to innovate which, according to Professor Kitch (1977), is partially what the U.S. patent system has been doing. Other private remedies include forming a patent pool (Yu, 1978, 1981) as well as a merger (Telser, this issue). The choice between these various solutions has never been made explicit. As critics of Professor Kitch have argued, the delineation of right to innovate in the form of "prospects" may only change the time frame of dissipation without mitigating it.<sup>7</sup> Similarly, one can legitimately argue that the particular contractual remedy suggested here would induce dissipation in another dimension, and there is no presumption whether one type of dissipating phenomena is more or less superior than another. Here, we believe the critics have not devoted sufficient attentions to the reply by Kitch: There is no question that any solution to a costly problem would itself be costly, and that a truly superior solution should be one involving the least cost -- one that has the lowest dissipating supply elasticity. However, until someone has studied the properties of an individual feasible solution, it would virtually be impossible to rank the transaction costs of various dissipating margins. Thus, concentrating on a particular feasible solution, though incomplete, is nevertheless a necessary scientific procedure for the investigation of a more general optimization problem.

To demonstrate how a study of our particular solution can help in analyzing the more general problem, consider the following avenues of

investigations:

(i) Comparing the solution here with the alternative contractual solution involving competing inventors, our solution involves only bilateral contracts between an inventor with independent manufacturers. Thus, the cost of "collusive" agreement must be balanced against the cost of a bilateral agreement. More specifically, if the number of competing inventors is large (small) relative to the number of end-products-producing and marketing outlets, we would expect cooperative agreement between inventors to be less (more) likely than the vertical integration alternative. Stated differently, if entry into production markets is harder (easier) than entry in the R&D market, we would expect vertical integration to be more (less) likely to be the contractual outcome.

(ii) Comparing the solution here with the political solution involving the granting of rights to "prospects," the solution here implies an information content on the market share of the production facilities of inventors. A nonintegrated inventor will be discouraged from rushing to innovate only if he believes substantial existing marketing facilities have been committed to the research outcome of the integrated inventors. On the other hand, the political solution involving "prospect" implies an information content on the timing and the number of patents. While a comparison between these alternative information sources awaits more detail formulation, both solutions would call for an investigation of various information channels by which inventors can base their decision on. And, if in actuality, no information channels of any kind are adopted, the noncooperative rushing result may indeed be the consequence.

There are other avenues of investigation concerning advertising, relationship between product market structure and R&D intensities, as well

as the general notion of Schumpeterian competition, but we will not elaborate them here. It suffices to point out that the unique features of our solution is only exogeneous from a modelling point of view. In view of the quasi-rent generated within the model, we would expect individuals to devote resources to acquire these pre-conditions. In fact, one could very well argue that, in the real world, nothing is exogeneous.

### Conclusion

Without claiming that vertical integration is necessarily the solution in the general global maximization problem, we conclude this paper by asking a practical question: Consider a young Ph.D. in the field of pharmacology of heart disease. Is he likely to establish his own research organization to compete with other experts (or other new Ph.D.s) in the area of heart disease, or is he likely to join the research organization that specializes in the field of heart disease? If the latter is the alternative chosen, we would not expect premature innovation to be the consequence. The point of this paper is that the development of specific research for operations spanning a substantial market share may induce the young pharmacologist to choose the second alternative.

Footnotes

\*I would like to thank Ron Batchelder and Bruce Kobayashi for many helpful discussions and suggestions. I have also benefited from the comments of Moshe Adler, Meyer Burstein, Harold Demsetz, Victor Goldberg, Jack Hirshleifer, and Ken Sokoloff on earlier drafts of the paper. All errors are mine.

<sup>1</sup>This is the most simplified version of the premature innovation argument. With perfect certainty in  $G$  and  $T(x)$ , there will only be one inventor in the equilibrium. With uncertainty in  $T(x)$ , excessive research expenditure comes in the form of entry of inventors. See the references cited in the introduction.

<sup>2</sup>See also Yu, 1981 and 1983.

<sup>3</sup>Several studies that motivate the thinking here are Nelson, 1974; Klein and Leffler, 1981; and Leffler (1981).

<sup>4</sup>See the debate in Goldschmidt, Mann and Weston, 1974, Chapter 3.

<sup>5</sup>See an elaboration of this general proposition in Cheung, 1970, 1974; Barzel, 1974.

<sup>6</sup>Thus, the sushi bar may adopt a policy of using only the fish caught by their fishermen, and an oil refinery would only refine crude oil discovered by its own company.

<sup>7</sup>See McFetridge and Smith (1980), and Kitch (1980).

References

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

\_\_\_\_\_, "A Theory of Rationing by Waiting," JLE (April 1974), 17, 73-95.

Bowman, Ward S., Jr., "Patent and Antitrust Law," Chicago, University of Chicago Press, 1973.

Cheung, Steven N. S., "Structure of a Contract and the Theory of a Non-Exclusive Resource," JLE (April 1970), 13, 49-70.

\_\_\_\_\_, "A Theory of Price Control," JLE (April 1974), 17, 53-72.

\_\_\_\_\_, "Contractual Arrangements and the Capturability of Returns to Innovation: Report of a Pilot Investigation" (Mimeo, University of Washington, Institute of Economic Research, 1976).

Dasgupta, Partha and Joseph Stiglitz, "Uncertainty, Industrial Structure and the Speed of R&D," Bell Journal of Economics (Spring 1980), 11, 1-28.

Goldschmidt, Harvey J., H. Michael Mann, and J. Fred Weston, "Industrial Concentration and the New Learning," Toronto, Little Brown and Co., 1974.

Hamberg, Daniel, "Invention and the Industrial Research Laboratory," JPE (April 1963), 71, 95-115.

Kamien, Morton I. and Nancy L. Schwartz, "Timing of Innovations under Rivalry," Econometrica (January 1972), 40, 43-60.

Kitch, Edmund W., "The Nature and Function of the Patent System," JLE (October 1977), 20, 265-90.

\_\_\_\_\_, "Patents, Prospects, and Economic Surplus: A Reply," JLE (April 1980), 23, 205-207.

Klein, Benjamin and Keith Leffler, "The Role of Market Performance in Assuring Contractual Performance," JPE (October 1981), 89, 810-34.

- Lee, Tom and Louis L. Wilde, "Market Structure and Innovation: A Reformulation," QJE (March 1980), 94, 429-31.
- Leffler, Keith, "Persuasion or Information? The Economics of Prescription Drug Advertising," JLE (April 1981), 24, 45-74.
- Loury, Glenn C., "Market Structure and Innovation," QJE, August 1979, 93, 395-410.
- McFetridge, Donald G., and Douglas A. Smith, "Patents, Prospects, and Economic Surplus: A Comment," JLE (April 1980), 23, 197-203.
- Nelson, Phillip, "Advertising as Information," JPE (July/August 1974), 82, 729-754.
- Schwartzman, David, "Innovation in the Pharmaceutical Industry" (Baltimore, Johns Hopkins Press, 1976).
- Telser, Lester G., "Innovation: Its Public and Private Aspects and Some of Their Empirical Implications," mimeo, University of Chicago, July, 1983.
- Wilson, Robert W., "The Effect of Technology Environment and Product Rivalry on R&D Effort and Licensing of Inventions," Review of Economics and Statistics (May 1977), 59, 171-78.
- Wood, Lawrence, "Patents and Antitrust Law," New York Commerce Clearing House (1942).
- Yu, Ben T., "Potential Competition and Contracting in Innovation," JLE (October 1981), 24, 215-38.
- \_\_\_\_\_, "Two Models of Competition in Innovation," UCLA Working Paper #287 (March 1983).
- \_\_\_\_\_, "The Economics of Patent Pools: The Capturing of Returns to Basic Research" (unpublished Ph.D. Dissertation, University of Washington, 1978).