

20 Bounded Rationality and Related Concepts Fundamental to Intellectual Property Analysis

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With the spread in use of the concepts of "laws and economics" in intellectual property studies, jurists as well as economists have recognized the importance of an ex-ante perspective in the analysis, i.e., how incentives can be changed by alterations in legal systems. While the concept of bounded rationality used to be frequently neglected in conventional "laws and economics," it has, since the 1990s, become a major issue in microeconomics. The concept of bounded rationality is the source of fundamental questions and study incentives for those who are engaged in ex-ante incentive analysis. Moreover, the patent system itself and various transactions related to patents inevitably entail transaction costs formulated by use of such concepts as "incompleteness," "indescribability," and "non-verifiability," all of which stem from bounded rationality. In this study, we reviewed the history of the previous studies and reconsidered the basis of the concept of efficiency in the economic analysis of patents. We also conducted empirical studies based on the presumption that the rationality is bounded.

Introduction

As an increasing number of people recognize the applicability of "laws and economics" to intellectual property study, legal scholars as well as economists are increasingly aware of the importance of the ex-ante viewpoint that enables them to predict what kinds of incentive-based changes an institutional change will bring about. For instance, the court decision for a dispute serves as a rule that fills gaps in laws or regulations. Moreover, the court decision will be used not only as a precedent for the purpose of court judgments in the future but also as a code of conduct applicable to private transactions. In short, it will influence incentives of individual economic entities in choosing what action to take. For this reason, it would be desirable for ex-post court settlement of individual disputes to take into consideration both the fairness and the economic efficiency of the court decision as a code of conduct that individual entities refer to before they take any actions. Needless to say, in the case of laws and regulations, which are established as general rules in the first place, the importance of rule efficiency is

even greater because the main purpose of those rules is to serve as a code of conduct for private economic entities.

Economists use the game theory as a standard tool, when conducting an analysis concerning the effects of ex-post rule-making on incentives and also concerning their effects on efficiency from an ex-ante viewpoint. Models were applied to various strategic relationships including information asymmetry and repeated relationships. For example, models were used to analyze competition between patent applicants and changes in competitive relationships depending on how patents are licensed. Thanks to the models, a large number of application studies were conducted on patents. In order to apply the models to those cases in an appropriate manner, we need to define the probability space regarding future events and the strategy space regarding the actions by each entity. In other words, the standard framework of the game theory does not function properly if each respective entity is unable to define in advance individual events that could happen in the future, i.e., in cases where each economic entity is unable to fully define every element of the event

space for which the probability should be determined (whereas the existence of uncertainty itself does not cause a problem). In such a case, some alteration of the framework is necessary. In this paper, we will first look at concepts such as describability and bounded rationality, which are used to predict future events or to define the limits in terms of calculativeness. After reviewing these concepts from theoretical studies accumulated in the past, we will describe how those concept can affect the framework of patent analysis. We will also conduct an empirical analysis on the patent system with the explicit application of the concept of bounded rationality.

Chapter I

Chapter I points out the importance of the concept of bounded rationality, which means that “the rationality of human being is bounded.” This concept was established by Herbert Simon^{(*)1} and Kenneth Arrow^{(*)2} several decades ago. Chapter I also outlines other concepts that have been developed in close relation to the concept of bounded rationality. Those other concepts include describability, verifiability, incomplete contracts, and transaction costs.

<Approach that does not take bounded rationality into consideration>

If we consider a simplified model of patent race, it would be clear that one of the basic issues of the patent system is whether the event space can be fully defined. The direct implication of this model is that the social welfare would be damaged if a patent system prompts companies to make many duplicate investments in their respective research and development activities. When each firm calculates the expected profits it could gain in return for its investment, the firm focuses only on itself and decides what action to take based on the calculated result. For this reason, collective decisions of

companies often do not maximize the social welfare. This problem could take the form of either underinvestment due to the lack of a patent system or overinvestment due to the existence of a patent system, which sometimes overstimulates corporate research and development activities, causing them to make duplicate efforts to develop the same technology. Either case would be socially undesirable.

Regarding this model, it should be noted that the rationality of the acting entity is unbounded even though there is uncertainty in problems related to the decision-making process of each firm. Even though the success of the research and development activities is uncertain, this uncertainty does not mean that the rationality is bounded. The presumption of the model is that each firm makes a decision based on the predicted returns, which are completely computable. Another presumption is that the technology that should be developed is known and the social value of the technology is known to the companies.

However, this presumption does not apply to the actual development of new technology for which a patent will be sought. This is because technology should at least be considered to be lacking non-obviousness if the technology that should be developed is predictable or definable by everyone in advance. Technology cannot be regarded as patentable unless it is new and difficult to conceive based on existing technology. A prerequisite for a patentable invention is that it cannot be accurately defined in advance. In short, the model is applicable as far as the probability space can be strictly defined ex ante. As a result, the model excludes a large part of the race for technological development in the real world, which is difficult to define in advance in principle.

Similarly, a patent, which functions as an exclusive right, is never granted as a “technology with certain value V.” The contents of each patentable technology can be

(*)1) Simon, Herbert. *Administrative Behavior*. New York: Macmillan; 1961.

(*)2) Arrow, Kenneth. *The Limits of Organization*. New York: Norton; 1974.

defined only ex post through the patent granting process because the technology has countless attributes that are difficult to identify in advance. If the goal cannot be specified beforehand even stochastically, it is impossible to determine the incentive mechanism. One of the characteristics of the patent system is to set the scope of a monopoly right ex post on the presumption that no one can accurately predict the technology to be invented.

<Approach that takes bounded rationality into consideration>

Tirole argues in his paper entitled "Incomplete contracts, where do we stand?"^{(*)3} that the existence of incompleteness in the sense that no one can tell what to invent in advance is the reason for a nation to promote technological development through a patent system, which grants monopoly rights to inventors, and not through a national bonus system. He also reiterates that one of the most important issues in economics is the concept of incomplete contracts and related concepts such as property rights and authority. In sum, an intrinsic and unique characteristic of the patent system is that it is difficult to tell a patentable invention in advance in principle. The concept of incompleteness is indispensable in the analysis of a wide range of property rights and contracts because such a concept has a close relationship with ex-ante bounded rationality. In other words, the concepts of bounded rationality and incompleteness are not special concepts used only to explain certain policies. Those concepts are basic concepts applicable to general matters. These concepts have a long research history and are not limited only to patent issues. Therefore, it would be useful to review the development of the concepts.

The concept of incompleteness stems

from transaction costs. In microeconomics, it is assumed in general that the allocation of resources in society is made through the market. However, the market is not the only resource allocation mechanism. Another form of resource allocation mechanism exists within firm organizations well. There must be a rational reason that justifies the existence of a resource allocation mechanism at each firm in addition to such a mechanism of the market economy. Coase concluded that there must be some mechanism to save transaction costs and presented the concept of "transaction cost" that affects "boundaries of the firm." In other words, the high transaction costs for market transactions must be responsible for a company's practice of conducting transactions within itself and not conducting market transactions to procure goods and services from outside, although such procurement from the market is possible. What is important about this concept is that the issue is the relative advantage between the "methods of economic transaction management" such as market transactions and internal corporate transactions. The relative difference among those methods in terms of efficiency is called transaction costs.^{(*)4}

In contrast to this concept of Coase established in 1937, Williamson pointed out that the core of the problem was the relationship between the characteristics of a transaction and those of the inter-temporal governance structure. He showed some of the attributes of a transaction as the elements that change the relative efficiency difference of the governance structures. For example, his conclusion is that, due to the characteristics of human beings such as bounded rationality^{(*)5} and opportunism, the more asset-specific and complex a transaction is, the more disadvantageous it would become in relative terms to manage

(*)3) Jean Tirole (1994), "Incomplete contracts, where do we stand? ", Walras-Bowley lecture delivered at the North American summer meetings of the Econometric Society, Quebec City.

The revised version of this paper does not address the issues related to the patent system as a system of incomplete contracts probably because of the limitation on the number of words imposed by the publisher.

Tirole, Jean, 1999, "Incomplete Contracts: Where Do We Stand?" *Econometrica*, vol.67, no.4, pp.741-781

(*)4) It should be noted that Coase examined static aspects only. Presuming that the searching cost was the major component of the transaction cost, he did not examine the efficiency of each governance structure from an inter-temporal perspective.

(*)5) Simon, Herbert, 1961, "Administrative Behavior," Macmillan.

the transaction as a simple market transaction. In sum, it becomes relatively more advantageous to conduct a transaction internally within one firm. In other words, he analyzed inter-temporal governance structures in a way that the efficiency as a whole would change as a result of governance choice.

Based on this concept, Grossman, Hart, and Moore created an original model called incomplete contracts models around 1990. These models are sometimes referred to as the description of hold-up problems through the property right approach because the models made it possible to explain the problems by use of simple models that disregard information asymmetry. This approach contributed to spreading the concept of "transaction cost" among economists once again following a period during which the concept of "transaction cost" was long rejected simply as tautology due to the lack of theoretical grounds. It is particularly meaningful that those models have made the following two ideas widely accepted. The first one is that the transaction costs other than those costs monetarily like telecommunications costs and the cost of the forms and manpower to prepare and conclude contracts are fundamentally important for a company to make a decision on the choice of governance. The other idea is that it is important to keep an inter-temporal perspective.

The important presumption within the frameworks proposed by Williamson, Grossman, Hart, and Moore is that it is difficult to define the scope of events that could happen in the future. The concept of bounded rationality was one of the essential elements of incomplete contracts because it was impossible for the party involved in a transaction to fully specify the subject matter of the transaction in advance. In sum, in the works of Williamson and Hart, we can see the trace of the concept of "bounded rationality," which was regarded as intrinsic by such

economists as Coase, Arrow, and Simon.

There are many definitions for incompleteness and incomplete contracts. One of the definitions does not assume the existence of indescribability and includes such an incomplete contract between the parties who have chosen not to fully specify the future events in advance although they could have done so if they chose to do so. A similar development has been observed in an analysis of a contract that takes a simple form but has self-binding functions over a long-term business relationships.^(*6) In essence, while the axiomatic conditions are yet to be established clearly,^(*7) what these arguments have in common is their claim that, in some cases, the non-market economic governance structure becomes necessary and more efficient when some of the following three conditions are met: (i) indescribability, (ii) non-verifiability, and (iii) inability to prohibit ex-post renegotiations based on mutual agreement between the parties concerned. While the definition of an incomplete contract and the scope of the definition are yet to be determined, it seems to be widely accepted that the concept of incomplete contracts and relevant concepts play extremely important roles for further understanding of the effectiveness of property rights and contracts. Underneath the widely accepted belief, there lies the unanswered question as to how the concept of bounded rationality should be treated from a theoretical perspective.

<Two standpoints regarding bounded rationality>

As described above, Most of the many economic models for patent analysis accumulated up till now were created based on the presumption that the probability space can be properly defined in advance so that ex-ante analysis is made possible. This presumption is, however, questionable. The presumption is rather a theoretical assumption made for the sake of convenience.

(*6) Levin, Jonathan, 2003, "Relational Incentive Contracts," *American Economic Review*, vol.93, no.3, pp.835-857.

(*7) Hideshi Ito, *Keiyakuno keizai riron* (Economic Theory on Contracts), Chapter IX [Yuhikaku, 2003]

Therefore, the assumption could be a subject of study in itself and should not, by any means, be regarded as the only possibility. In order to study how those models function in reality, it is important to take an empirical approach.

Chapter II

Chapter II examines how those basic concepts are applied. As outlined in Chapter I, this paper focuses on various concepts such as bounded rationality. Those concepts are often excluded from current analyses on incentives. As no uniform method for using concepts such as bounded rationality has been established, there are mixed views on the meaning of those concepts in reality. It is therefore not our intention to deny the main stream analytical framework and propose a replacement. What we can do instead is to describe empirical studies with the explicit application of the concept of bounded rationality. Such a study is proven to be possible as it has been conducted for more than ten years. Chapter II briefly describes “transaction cost,” which is one of the basic concepts used in such empirical study, and “the optimization of the private governance structure.”

Coase adopted the viewpoint of choice with marginal costs in his original paper in which he presented the concept of transaction costs. The market mechanism can be characterized by the problem of marginal choice, which can be summarized as “if the price of a production factor A is higher in X than in Y, the factor A will be adjusted from X to Y until the price difference between X and Y disappears (other conditions being equal).” Similarly, the expansion of a firm is interpreted as an issue of choice in an attempt to make the marginal costs equal as he explained that “--- until the cost of establishing an internal structure within the firm for additional transactions becomes

equal to the cost of carrying out the same transactions through open market exchanges.” For example, it is commonly believed that a firm makes a choice from between institutional options such as its internal system and a contract for market transactions based on the difference in relative costs (in such a way that makes marginal costs equal). In short, it is implicitly assumed that any economic entity that chooses an inefficient option will eventually cease to exist. The choices made by companies and the market are assumed to be a static equilibrium in the long run. Thus, anything that continues to exist in reality could be statistically suggesting that the continued existence is attributable to its relative efficiency.

We take an endogenous approach to studying the legal structure including rights and contracts in the sense that private ordering is established in the pursuit of rationality and cost saving. In this respect, we try to expand the conventional framework of “laws and economics” by replacing a part of its presumptions with new ones.

These standpoints have been taken by researchers who tried to analyze the research and development processes and the functions of patents in the society as a whole. Initially, studies concerning the forms of technology transactions were conducted by examining methods of technology transfer to another country, such as internal transfer or licensing the technology to a third party. It is predicted, based on the concept of transaction costs, that a firm that has developed technology will choose to use it internally if the cost of preparing a contract to license the technology to another party is very high. In the case of an international technology transfer, it would take the form of direct investment rather than licensing. Empirical studies verified the fact that technology is likely to be transferred through direct investment if the technology has recently been developed or the technology consists of knowledge that is difficult to

explain in writing.^(*8) This indicates that the degree of indescribability positively correlates with the frequency of the use of the nonmarket transaction management method. This correlation is also suggested by the logic of transaction costs.

A study conducted by use of the patent citation data^(*9) of the United States verified that the nonmarket governance is likely to be chosen by a firm involved in a knowledge transaction where it is difficult for a court to enforce the contract *ex post*. For example, one study^(*10) shows that mutual patent citation is made more often in the case of a technology transfer and joint research development among companies that have capital ties with one another than in such transfer and development between companies that have no capital ties. This finding is the same as that of an empirical study^(*11) which concluded that a contract is likely to be struck among companies that have capital ties with one another especially when the licensing of the technology is likely to damage the appropriability of the technology. A citation can be used as a proxy variable of knowledge transfer because the citation is a result of new technology development based on the transferred knowledge. This indicates the fact that the licensing of existing technology contributes to future innovation and therefore that the indescribable results of *ex-post* technology development are also implicitly subject to the transaction.

Many studies have taken the approach that the research and development process should be analyzed on the assumption that the private governance structures differ in efficiency. Above all, it is necessary to recognize that transactions exist in the process of research and development in the society as a whole. A patent allows the owner

to legally monopolize an invention. However, it should not be limited to permission for the exclusive use of the invention but should rather contribute to promoting business transactions. Furthermore, business transactions connected with any technology protected under the intellectual property system are indispensable for the process of social diffusion of technical development results. Promotion of such transactions is one of the major purposes of the intellectual property system. Therefore, for our better understanding of the diffusion mechanism of technology after its development, it is beneficial to examine which technology “transaction” method is selected by each private economic entity under the intellectual property system.

Chapter III

Chapter III presents some examples of empirical study that take the concept of bounded rationality into account in ways other than the above-mentioned “optimization of the private governance structure.” More specifically, we focus on divisional applications that tend to be conducted for technology of important value. We analyze data to examine whether the concept of bounded rationality is applicable to the use of the divisional application system by patent applicants anticipating subsequent research and development. If an applicant is able to predict development trends in the distant future and devise measures in advance accordingly, he will try to refine his claims as much as possible through modifications and divisions. This would especially be true if the patent application is for promising technology that is expected to

(*8) Davidson, W.H. and Donald McFetridge, 1984, “International Technology Transactions and the Theory of the Firm,” *Journal of Industrial Economics*, vol.32, no.3 pp.253-264.

Kogut, Bruce, and Udo Zander, 1993, “Knowledge of the firm and the evolutionary theory of the multinational corporation,” *Journal of International Business Studies*, vol.24 no.4, pp.625-645.

(*9) Jaffe, Adam, Manuel Trajtenberg, and Michael Fogarty, 2000, “Knowledge Spillovers and Patent Citations: Evidence from a Survey of Inventors,” *American Economic Review*, vol.90 no.2 pp. 215-218

(*10) Mowery, David, Joanne Oxley, and Brian Silverman, 1996, “Strategic Alliances and Interfirm Knowledge Transfer,” *Strategic Management Journal*, vol.17 pp.77-91.

Wada, Tetsuo, 2001, “Equity Joint Ventures and the Scope of Knowledge Transfer between Diversified Firms: Evidence from U.S.-Japan Alliances,” paper presented at the 5th Annual Conference of the International Society for New Institutional Economics.

(*11) Oxley, Joanne, 1997, “Appropriability Hazards and Governance in Strategic Alliances,” *Journal of Law, Economics, and Organization*, vol.13 no.2, pp.387-409.

have very long-term implications significance. If the applicant has bounded rationality, it means that he has the limited ability to predict basic technology trends. If this is the case, there is always a discrepancy between the value index predicted from the ex-ante action of the applicant and the ex-post value index.

As a precondition, we need to consider the probability of divisional applications becoming a proxy variable of economic value. Many empirical studies conducted in the past support the argument that the length of a period during which a patent is kept renewed can be an indicator of the ex-post private value of a patent. If a patent is expected to generate private profits, a proportionate amount of costs will be paid. Therefore, the private costs can be an ex-post indicator of the private value of the patent. Since divisional applications incur a certain amount of expenses, they would not be conducted if a proportionate amount of private profits are not expected to be generated. For these reasons, there is a likelihood that divisional applications will be used as a private value indicator.

Based on information on the frequency of forward citations, which indicates how often a certain patent is cited by subsequent patents, we conducted a study to find out whether divisional applications can be used as an indicator of economic value. In this study, we differentiated proactive divisions, which are conducted voluntarily and strategically, from reactive divisions, which are conducted in response to an external event such as the receipt of a notice about the reason for rejection. We combined the patent data of Japan with that of the United States through use of international patent family data and analyzed the combined data. We found that patent division showed the level of economic value of the original application even after we controlled many other relevant factors. The same applies to the case of proactive division, which is voluntarily conducted by the applicant. Thus, it can be said that divisional application can be a private and ex-ante indicator externally

observable from even the time prior to the commencement of the patent examination.

In addition to the differentiation between the proactive division and reactive division of a patent, we classified divisional applications into two groups based on the timing for the development of related technology. Then we analyzed each class and found that applicants' choice of divisional application, i.e., which type of division was conducted, is dependent on the cumulative technological development. We noticed that proactive division, which is carried out voluntarily and strategically, was more strongly influenced by the surrounding technological development. In other words, in view of the fact that division can be a private and ex-ante value indicator, we were able to conclude that proactive division was probably influenced by the trends in the surrounding technological development observable at that time. If an applicant was able to predict trends in technological development into the distant future and devise countermeasures accordingly, he would carefully refine the claims for any technology that is expected to give rise to a series of products to which the technology would be applied. However, the fact that this is not the case in reality, seems to indicate the existence of the bounded rationality of the applicant.

These study results would have policy implications as follows. The systems of divisional application and correction as well as the United States' system of continuation applications are socially costly systems because the permission for division and correction of an application over a long period of time tends to result in a prolonged examination period. The resulting delay in the finalization of the right would also deter investment by rival companies and cause other problems. Admittedly, technology subject to divisional application usually has a high social value as shown in this paper. Therefore, it would be justifiable to some extent to pay the public costs of conducting additional examination for the purpose of allowing applicants to modify and refine their respective claims. Such public cost incurred

would also contribute to the private interest of any applicant who submits a divisional application in spite of additional costs such as a handling fee.

However, any applicant who intends to submit a divisional application is not in a position to do much more than observe the technological development currently in progress due to the limited ability to predict future trends in technological development. Therefore, he is unable to judge the necessity of modifying his claims in anticipation of the long-term technological effects on the society as a whole. This explains the inevitable failure experienced by an applicant in an attempt to choose the most fundamental and basic innovation from among cumulative innovations that could be made many years after the original invention. The applicant tries to make such a choice before submitting a divisional application in order to gain strong protection for the fundamental innovation, but cannot avoid his limitation in predicting future developments.

Conclusion

The concept of bounded rationality used to often be neglected in the conventional sphere of "laws and economics." Since the 1990s, however, it has become a major issue in economics. This paper aims to review the basis for economic analysis of intellectual property rights. It also studies future possibilities by presenting other approaches that could provide appropriate research frameworks.

The cost to exercise a patent right has become an increasingly important issue for companies in the face of an increase in the number of patent infringements, patent disputes, damages claimed, and litigation costs. Needless to say, one of the actual problems is a direct cost of exercising a patent right. This cost takes the form of a search for a latent infringement in order to exercise the right in question. Even if a holder of a patent that is established so clearly that allows no room for dispute over

its interpretation, he/she can not be exempted from the cost. Furthermore, as discussed in Chapter III, a patent right itself is intrinsically incomplete in principle. Therefore, applicants should deal with such issues as the equivalents and the prosecution history estoppel, which tend to cause problems attributable to future uncertainty. For this reason, applicants have to incur costs that are difficult to express in monetary terms. As described in Chapter I, the patent system itself and various transactions related to patents inevitably entail transactions costs formulated by use of such concepts as "incompleteness," "indescribability," and "non-verifiability," which stem from bounded rationality. Related to these theoretical issues, many problems remain unsolved. Further study should be conducted by adopting new approaches and revising current ones.

A study approach that should be newly adopted or revised is not designed to directly question the appropriateness of laws themselves in normative sense but is rather designed to deepen the understanding of behavioral laws applicable to the relationships between the rules and the conduct of private economic entities. It would not be enough to pay attention only to the patterns of the direct effects of legal norms, which can be regarded as outside conditions, on conduct. For example, self-enforcing contracts, which are privately created, managed, and implemented rules applicable to individual economic entities, are, in fact, endogenous rules established by respective private economic entities by choice and therefore should be regarded as an object for analysis and not as given outside conditions. In other words, a two-way analysis is necessary whereas the classic "laws and economics" consider the rules are given as outside conditions and subserviently observe the choice of conduct. Endogenous study of both conduct and a part of the rules will remain important. Such study should include the method to privately manage transactional relationships. One example of such study is an empirical study of the

contractual relationships conducted in consideration of transaction costs. As seen in Chapter II, many high-quality studies have been carried out through this approach, suggesting clues for theoretical and empirical development. Future study is expected to empirically verify theoretical predictions by using an economic theoretical framework based mainly on the concept of bounded rationality and, as described in Chapter III, to gain a new theoretical insight by identifying contradictions between theoretical predictions and actual data.