Firm's Strategic Responses in Standardization

Nguyen Huu Phuc

Graduate School of Innovation & Technology Management, Yamaguchi University
Address: 1677-1 Yoshida, Yamaguchi, 753-8511, Japan
E-mail: phuc@yamaguchi-u.ac.jp

Abstract: From the perspective of game theory, this paper examines 1) Why do companies participate in standardization activities and patent pools, even if the activities benefit their rival companies; 2) When there are multiple standards of similar products, under what conditions will these multiple standards be replaced by a de facto standard, 3) When will these multiple standards coexist together? 4) What are the strategic responses of the companies then?

Keywords: Standardization; Cross license; Patent pool; Game theory.

INTRODUCTION

We live in a world profoundly reliant on product standards. Computers have various standardized protocols to be able to share files and use different hardware and software; faxes can be sent because of a common protocol, etc. On the other hand, standardization also leads to escalate market competition that does not benefit the manufacturing companies.

A "standard" is to be defined as the one in [3], that is, "as a set of technical specification adhered to by a producer, either tacitly or as a result of a formal agreement." Standards, for the purpose of this paper, falls into the following categories based on two characteristics: whether the standard is sponsored (or proprietary) or unsponsored (or non-proprietary), and whether it is a de facto (ex-post) or de jure (ex-ante) standard.

Sponsored standard can be used only by the companies holding the property rights related to the standard. These companies will create inducements for other companies to adopt particular sets of technical specifications. Unsponsored standard, however, have no identified proprietary holders. Anyone can use the unsponsored standard.

There is another distinction between standards available in the industry - de facto and de jure. De facto standard is an ex-post standard that has achieved a dominant and accepted position. It may be adopted through a standards war (market driven) or due to a lock-in effect. We also have de jure (ex-ante) standards that are developed by accredited standards organizations using rigid procedures that may periodically be audited.

From the perspective of game theory, this paper examines the following questions:

1) Why do companies participate in standardization activities and patent pools, even if the activities benefit their rival companies?

2) When there are multiple standards of similar products, under what conditions will these multiple standards be replaced by a de facto standard?

3) When will these multiple standards coexist together?

4) What are the strategic responses of the companies then?

5) Precedent standard does not imply that it will be the de facto standard.

The above-mentioned questions are the popular topics in earlier literatures. These literatures used the "tragedy of the anti-commons" concept introduced in [1] to explain question 1. Many economic analyses have been done to answer questions 2, 3, 4 and 5 such as the pioneering study by [4], and then [5], [6], [7], [8], [9], [10], [11], and [12]. One of the findings in this paper is that by only "the tragedy of the anti-commons" concept, one cannot explain why cross-licensing occurs. This paper also offers a simplified framework of game theory in a consistent model to answer these questions. The framework can be extended without difficulty to a dynamic game model to study sophisticated cases.

THE TRAGEDY OF THE ANTI-COMMONS AND THE COMPETITION BETWEEN STANDARDS

[2] analyzed the "tragedy of the anti-commons" (referred to as a "patent thicket" in [13]) in connection with intellectual property. It is a mirror image of the "tragedy of the commons" meaning that where several parties possess exclusive rights in a scarce resource, and it is costly, difficult or impossible for property rights holders to bundle these rights or to agree on how to apportion the resource, the resource will remain unutilized. On the other hand, the tragedy of the anti-commons refers to a situation when there are several parties own patents

covering a certain technology, process or invention, each can exercise their exclusive rights to prevent others from using, developing or marketing that technology, process or invention. The proliferation of fragmented and overlapping patent rights is increasingly being recognized as a serious problem. Therefore, where it is too costly to reach a licensing agreement, the technology, process or invention remains undeveloped.

Here the tragedy of the anti-commons can be demonstrated by using the game theory.

We consider a model where there are companies A, B and (n-1) parties who own patents covering a certain product. All parties have a choice to license its own patent or not.

Furthermore, the generalization of the model does not change if we assume that:

1. Only company A and company B are the manufacturers of the product and the other patent holders are not manufacturers or do not have interest in producing the product.

2. The license income is set up equally at the amount α for every patent holder agreeing to license its own patent regardless of what patents they possess.

Case 1: If there is any patent holder who does not license its patent, the tragedy of the anti-commons occurs and all players will receive null payoffs.

Case 2: All patent holders except A and B agree to license their own patents at the license fee α for each patent holder. Companies A and B's choices are demonstrated as in the following table.

Table 1 - The tragedy of the anti-commons in game theory

Payoffs to: (A, B)		Company B	
		NOT license B's patent	LICENSE B's patent
Company A	NOT license A's patent	$(0, 0)$	$(1-n\alpha, \alpha)$
	LICENSE A's patent	$(\alpha, 1-n\alpha)$	$(0.5-n\alpha, 0.5-n\alpha)$

Companies A and B's action set is {to license its patent, not to license its patent}.

If both companies refuse to license, there is no production and their payoffs will be null (a case of the tragedy of anti-commons).

If only one of them agrees to license and $(1-n\alpha) > 0$, the other company who refuses to license will monopolize the market. However, if $(1-n\alpha) \leq 0$, then there is no production. Their payoffs will be null.

If both of them agree to license to each other (cross-licensing) and $(0.5-n\alpha) > 0$, then the payoff will be divided between them. However, if $(0.5-n\alpha) \leq 0$, then as above, there is no production and their payoffs are 0.

$(1-n\alpha, \alpha)$ and $(\alpha, 1-n\alpha)$ are the best for companies A and B respectively. Both are also the Nash equilibrium's payoffs of the Battle of the Sexes game. Unlike in the Prisoner's Dilemma, the one who moves first is important in the Battle of the Sexes. The player who moves first will have a first-mover advantage.

The game results can be interpreted as:

1. The cross-licensing solution is not the equilibrium and $(0.5-n\alpha) > 0$ is a necessary condition for the implementation of cross-licensing. Therefore, by only "the tragedy of the anti-commons" concept, one cannot explain why cross-licensing occurs. We will give a different

explanation in the next part.

2. If (1-nα) ≤ 0, the company will abandon the idea of producing the product because the costs associated with the patents are too high. In other words, in an industry that the number of patent holders is small, there is a higher probability that the company will monopolize the market. It also means that cross-licensing or standardization solution is very rare here. One of the examples is the pharmaceutical industry where a single patent is all that is required to produce a marketable product.

3. Even when (1-nα)> 0, and all the essential patents to manufacture the product can be secured, it may lose the game, if it is not the first-mover (which is equivalent to commitment) in the game.

The sufficient condition to prevent the tragedy of the anti-commons is (0.5-nα)> 0. Therefore, one of the requirements to participate in a standardization organization is to grant licenses at reasonable terms. However, the competition between the standards, not the tragedy of the anti-commons, is the very thing to assure the cross-licensing or standardization solution. Let us consider a model where there are two groups of companies: group 1 including companies A and B; and group 2 including companies C and D. Companies A and B require the patents from its counterpart (A or B) to manufacture a new product. Companies C and D also require the patents from both of them (C and D) to produce a similar product. However, the patents of companies A and B do not overlap with those of companies C and D. Obviously, the desirable solution for each group to survive in the new market and reduce cost is to cross-license their patents within its group.

STRATEGIES IN THE CASE WHERE MULTIPLE STANDARDS EXIST

This part follows as an extension to the above discussion that when multiple standards exist
1) When will these multiple standards be replaced by a de facto standard?
2) When will these multiple standards coexist together?
3) Then, what are the strategic responses of the companies?

We consider a model where the players have a choice between two new standards: U and V. There are two manufacturing companies, whose preferences are as follows: it is common knowledge that company A prefers the standard U, and company B prefers the standard V. When company A uses the standard U and company B uses the standard V, their payoffs are u and v respectively. If both companies A and B adopt the same standard, due to the synergy effect, their added payoffs are x and y respectively. However, if company A chooses the standard V and company B chooses the standard U, payoff will be 0.

Table 2 – Multiple standards in game theory

Payoffs to: (A, B)		Company B	
		Standard U	Standard V
Company A	Standard U	u + x, y	u, v
	Standard V	0, 0	x, v + y

There are several interpretations of the payoff u (or v) and payoff x (or y). For example, to company A, the payoff u can be considered as "the value of the favorable standard" that it can get when applying the standard U regardless of whatever its counterpart chooses. The payoff x, on the other hand, implies the added value when the de facto standard emerges, "the added value of the de facto standard".

Now let us take a look at the equilibrium of the game.

Case 1: u > x and v < y

Company A has a dominant strategy. Company A obtains better payoff with the standard U regardless of whatever company B chooses. The dominant-strategy equilibrium is (U, U). As a result, the standard U will become the de facto standard.

Moreover, because the equilibrium is a dominant-strategy equilibrium, it is robust to substantial changes and the information structure of the game does not matter. That is, the equilibrium is unchanged whether company A or company B moves first. It implies that in this case, even if the standard V is the precedent standard, it will not be the de facto standard.

Case 2: u < x and v > y

This case is the opposite case of case 1. The standard V will become the de facto standard.

Case 3: u > x and v > y

Both companies have dominant strategies. The dominant-strategy equilibrium is (U, V). Consequently, two standards will coexist together peacefully. Regardless of who moves first, the equilibrium is also unchanged. In other words, establishing a standard earlier gives no advantage to be a de facto standard.

Case 4: u < x and v < y

It is a game of Battle of the Sexes. There are two Nash equilibriums: (U, U) and (V, V). Both companies prefer a same standard. Only in this case, the one who moves first is important and affects the payoffs of them.

The game results can be interpreted as:

1. Case 1 implies that it is easy for a company to establish a de facto standard from its favorable standard if 1) its favorable standard's value outshines its added de facto value, and 2) have a strategy to support (or secure) the future added value of the de facto standard for the counterpart (v < y for company B). Because the value of favorable standard seldom exceeds the added value of the de facto standard, this case is rare in business.

2. When a de facto standard does not benefit both players, the players will be satisfied with multiple standards (case 3). An example for this case is where multiple standards in DVD recordable formats (DVD-R, DVD+R) coexist, due to the increasing numbers of dual-format devices that can record both formats. As a result, the market for recordable DVD technology shows little sign of settling down in favor of either the plus or dash formats.

3. If the added value of a de facto standard surpasses the value of the favorable standard for both players, the player who establishes its standard first will have a great advantage to secure the de facto standard (case 4). This case is quite common in business.

REFERENCES

[1] Michael A. H. The Tragedy of the Anticommons: Property in the Transition from Marx to Markets. Harvard Law Review, 1998, 111(3): 621-688.

[2] Michael A. H. et al. Can Patents Deter Innovation? The Anti-commons in Biomedical Research. Science, 1998, 208(1): 698-701.

[3] David, P. A. and S. Greenstein. The Economics of Compatibility Standards: An Introduction to Recent Research. Economics of Innovation and New Technology, 1990, 1: 3-41.

[4] Hemenway D. Industrywide Voluntary Product Standards, Ballinger Publishing Company, 1975.

[5] Farrell J. and G. Saloner. Standardisation, Compatibility and Innovation. RAND Journal of Economics, 1985, 16(1): 70-83.

[6] Katz M. L. and C. Shapiro. Network Externalities, Competition and Compatibility. American Economic Review, 1985, 75 (3): 424-440.

[7] Katz M. L. and C. Shapiro. Technology Adoption in the Presence of Network Externalities. Journal of Political Economy, 1986, 94 (4): 822-841.

[8] Katz M. L. and C. Shapiro. Product Compatibility Choice in a Market with Technological Progress. Oxford Economic Papers, 1986, 38: 146-165.

[9] Katz M. L. and C. Shapiro. Product Introduction with Network Externalities. Journal of Industrial Economics, 1992, 40 (1): 55-84.

[10] Katz M. L. and C. Shapiro. Systems Competition and Network Effects. Journal of Economic Perspectives, 1994, 8(2): 93-115.

[11] Katz M. L. and C. Shapiro. On the Licensing of Innovations. RAND Journal of Economics, 1995, 16(4): 504-520.

[12] Conner K. R. Obtaining Strategic Advantage From Being Imitated: When Can Encouraging "Clones" Pay? Management Science, 1995, 41 (2): 209-225.

[13] Shapiro C. Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting. Competition Policy Center, 2000, Paper CPC00-011.