Over-Declaration of Standard Essential Patents (*)

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Standards play important roles in our everyday lives, for example, DVD, LTE, WiFi, and mobile phone standards. To promote innovation and accelerate the adoption of new technology, Standard Setting Organizations (SSOs) require their members to declare Standard Essential Patents (SEPs) and license them on fair, reasonable, and non-discriminatory (FRAND) terms. SEPs are patents that protect technologies essential to a standard. Because of the impact on innovation and the process of standard development, policymakers and market observers pay great attention to SEPs. An SEP is declared by its proprietor. Nevertheless, the essentiality of these patents is not controlled by anyone. IP holders have a solid incentive to possess SEPs, so they may attempt to declare inessential patents as SEPs. In this research, we attempt to analyze IP holders' strategic behavior by applying a theoretical model.

We were able to obtain the following results. First, ex-post assessment of the essentiality of declared SEPs can mitigate the over-declaration of SEPs. Second, if the essentiality of patents is low, ex-post assessment greatly decreases firms' declarations. Third, firms' R&D efforts also decrease due to ex-post assessment.

I. Introduction

Standards play important roles in our everyday lives, for example, DVD, LTE, WiFi, and mobile phone standards. In order to promote innovation and accelerate the adoption of new technology, Standard Setting Organizations (SSOs) require their members to declare Standard Essential Patents (SEPs) and license them on fair, reasonable, and non-discriminatory (FRAND) terms. Because of the impact on innovation and the process of standard development, policymakers and market observers pay great attention to SEPs. In this paper, we consider the Over-Declaration of Standard Essential Patents by applying a theoretical model.

II. Standards and Standard Essential Patents

Standard Essential Patents (SEPs) means patents covering technology necessary to comply with a standard. By definition, the implementor of a standard must make a licensing contract with the SEP holder. Therefore, SEPs generate significant benefits for their holders. For example, the "Hold-up problem" is one of the most controversial terms in discussions on standard essential patents since an SEP holder has strong bargaining power in licensing contracts. To mitigate this

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problem, most SSOs require the Patent Owner to grant licenses on FRAND terms.

III. Literature

Standardization is a relative young field of research in economics. Despite the growing importance, most theoretical studies have not focused on SEP declaration and licensing. There are some papers that attempt to capture the characteristics of SEPs. For example, Rysman and Simcoe (2008) shows that high-value patents tend to be declared as SEPs. Pohlman, Neuhausler and Blind (2016) focus on the relationship between standard essential patents and holders' financial performance. Lemley and Shapiro (2013) and Lerner and Tirole (2015) demonstrate the general model to examine standardization and show that ex-ante price commitments like a FRAND term improve efficiency. These studies implicitly assume that SEPs are truly essential to the standard and do not pay attention to the strategic behavior in declaration of SEPs.

Standard essential patents are declared by their proprietor. Nevertheless, the essentiality of these patents is not controlled by anyone. IP holders have a solid incentive to possess SEPs, so they may attempt to declare inessential patents as SEPs. Several studies concluded that only 20%, 27% and 28% of patent families declared 'essential' were actually essential. Cyber Creative Institute 2013, for example, attempted to evaluate LTE essential patents. They showed that truly essential patents make up only 56.0%. The inflation in the number of declared SEPs increases the costs of reaching a licensing agreement. In addition to that, there is some social cost involved in an IP holder disguising inessential patents as SEPs. Therefore, policymakers (for example, the EPO) are paying attention to that problem.

Regibeau et.al (2016) suggests two approaches to mitigate the over-declaration of SEPs. One approach is to make SEP declaration costly. The other is random SEP assessment. However, it is not clear which policy is socially desirable. In this research, we consider the effective policy to extenuate the over-declaration of SEPs. In addition, the existing theoretical literature does not pay sufficient attention to IP holders' strategic behavior in the declaration phase. In order to discuss the social benefits of these policies, we need to shed light on IP holders' incentives concerning SEP declaration.

In this research, we attempt to analyze IP holders' strategic behavior by applying a theoretical model. By applying a theoretical analysis, we can see how to make IP holders declare only truly essential patents as SEPs.

IV. Model

We assume there exist two firms in the market. Only firm 1 can obtain patents through R&D efforts. Firm 2 has core components to make products. The total profit from the standard is given by Π. We consider the case where both firms try to split this profit by bargaining. Firm 1's share of the total profit is given by $S_1(E, D, M) = 1/2 + (E + D - M)/2$, where E means the number of truly essential patents, D is the number of declared inessential patents and M means the number of core components of firm 2. We also assume that the R&D cost of firm 1 is equal to R. If firm 1 needs to pay C to disguise inessential patents as SEPs, its profit function is given by

$$\pi_1 = \left(\frac{1}{2} + \frac{E + D - M}{2}\right)\Pi - C - R$$

The timing of this game is as follows.

Stage 1: R&D by upstream firm (firm 1).

Stage 2: Upstream firm decides degree of over-declaration.

Stage 3: The government assesses the SEPs declared by firm 1.

Stage 4: Upstream firm and downstream firm (Implementer) split the profit.

1. The government does not assess the essentiality of declared SEPs.

We assume that the declared patents are treated as SEPs if the government does not assess the essentiality of declared patents. The number of inessential patents is equal to *F*. Firm 1 sets declaration rate r $(0 \leq r \leq 1)$ to maximize his profit. In this setting, $D = r \times F$. The optimal r depends on the declaration cost and the probability that the patent can pass the ex-post assessment. The declaration cost of this model is given by $C = \alpha F r$. α means the degree of declaration cost. We can rewrite firm 1's profit as follows

$$\pi_1 = \left(\frac{1}{2} + \frac{E + Fr - M}{2}\right)\Pi - \alpha F r - R$$

From this equation, we can obtain the following lemma.

Lemma 1: If ex-post assessment does not exist,

1. *Firm 1 declares all inessential patents as SEPs when α<Π/2*
2. *Firm 1 does not declare at all when α≥Π/2*

The intuition of this lemma is clear. If the declaration cost is relative low, the marginal revenue of declaration is larger than the marginal cost of it. In this case, firm 1 has an incentive to declare

all inessential patents as SEPs. Otherwise, it does not declare at all since the declaration is costly for the firm.

2. The government assesses the essentiality of declared SEPs.

(1) The essentiality of declared patents is relatively high

The probability that the declared patent cannot pass the assessment is equal to p. If firm 1 chooses declaration rate r, the lowest possibility that can pass the assessment is equal to $1-p(r)$. We assume that if firm 1 has inessential patents for which the essentiality is relatively high, $p(r)$ satisfies the following assumptions.

$$\begin{gathered} p(0)=0, p(1)=1 \\ \frac{dp(r)}{dr}>0, \frac{d^2p(r)}{dr^2}>0 \\ \lim_{r\to 0}\frac{dp(r)}{dr}=0,\ \lim_{r\to 1}\frac{dp(r)}{dr}=\infty \end{gathered} \tag{1}$$

Then, we can calculate the expected number of declared patents when ex-post assessment exists. We also assume that the inessential patents that cannot pass the assessment are eliminated from the SSO patent database. Then, the expected number of declared patents D_a is given by

$$D_a = F\times\int_0^r \big(1-p(t)\big)dt \tag{2}$$

From this equation, we can obtain firm 1's profit with the assessment as follows

$$\pi_a = \left(\frac{1}{2}+\frac{E+F\int_0^r\big(1-p(t)\big)dt-M}{2}\right)\Pi-\alpha Fr-R \tag{3}$$

(2) The essentiality of declared patents is relatively low

If we consider the case where firm 1 has inessential patents whose essentiality is relatively low, $p(r)$ satisfies the following conditions.

$$\begin{gathered} p(0)=0, p(1)=1 \\ \frac{dp(r)}{dr}>0, \frac{d^2p(r)}{dr^2}<0 \\ \lim_{r\to 0}\frac{dp(r)}{dr}=\infty,\ \lim_{r\to 1}\frac{dp(r)}{dr}=0 \end{gathered} \tag{4}$$

In this setting, firm 1's profit function with the assessment is given by equation (3).

3. How does ex-post assessment affect firm 1's declaration rate?

We can calculate the optimal declaration rate from equation (3). The next lemma shows firm 1's strategy.

Lemma 2: If ex-post assessment exists,

1. *When* $\alpha < \Pi/2$*, firm 1's optimal declaration rate* r_a $(0 \leq r_a \leq 1)$ *satisfies*

$$p(r_a) = \frac{\Pi - 2\alpha}{\Pi} \tag{5}$$

2. *When* $\alpha \geq \Pi/2$*, firm 1 does not declare at all*

When the declaration cost is large, we can obtain similar results to Lemma 1. If the government assesses firm 1's declared patents, the marginal revenue of declaration decreases since patents that cannot pass the assessment are eliminated. In addition, we can obtain an inner solution since we assume that the essentiality decreases as the declaration rate increases. We can consider the comparative statics about r_a in the next lemma.

Lemma 3: If ex-post assessment exists and α is smaller than Π/2,

1. r_a *is a decreasing function of α*
2. r_a *is an increasing function of Π*

The intuition behind this lemma is as follows. If the declaration cost increases, firm 1 will decrease its declaration rate to save cost. If total profit from standard Π is large, firm 1 has a strong incentive to increase its share of profit by the declaration. The next proposition considers how the essentiality of a declared patent affects the optimal declaration rate.

Proposition 1: If ex-post assessment exists and α is smaller than Π/2, r_a *becomes larger than when the essentiality of declared patents is low.*

If the essentiality is low, the number of expected declared patents greatly decreases because of ex-post assessment. Then, the optimal declaration rate becomes small when the essentiality is low.

4. How does ex-post assessment affect firm 1's R&D?

In this section, we consider the R&D stage. We assume that firm 1 can obtain a patent from R&D

at stage 1. The total number of patents is equal to *D*. The proportion of Standard Essential Patents to total patents is equal to γ. 1-γ is the ratio of inessential patents. We also assume that R&D cost *R* is given by

$$R = \frac{\beta D^2}{2} \tag{6}$$

Then, we can calculate firm 1's profit in stage 1 as

$$\pi = \left(\frac{1}{2} + \frac{\gamma D + (1-\gamma)Dr^* - M}{2}\right)\Pi - \alpha r^*(1-\gamma)D - \frac{\beta D^2}{2} \tag{7}$$

Where r^* is the declaration rate decided at stage 2. From this equation, we can obtain the marginal revenue of R&D as

$$\mathrm{MR_D} = \left(\frac{\gamma+(1-\gamma)r^*}{2}\right)\Pi \tag{8}$$

When firm 1 obtains a patent, it becomes an SEP with probability γ. If firm 1 gets an essential patent, he can obtain the profit by increasing his profit share. The patent may be an inessential patent with probability (1-γ). In this case, firm 1 has to declare its inessential patent as SEPs to obtain profit. The marginal revenue of R&D consists of these two effects. Similarly, we can obtain the marginal cost of R&D as

$$\mathrm{MC_D} = \alpha r^*(1-\gamma) + \beta D \tag{9}$$

The first term of this equation means the declaration cost of the inessential patent. The second term is equal to the marginal cost of R&D. From these equations, we can obtain the following lemma

Lemma 4: Firm 1's optimal number of patents D^* is given by

$$D^* = \frac{\Pi(\gamma + (1-\gamma)r^*) - 2r^*\alpha(1-\gamma)}{2\beta} \tag{10}$$

where α must be smaller than $\Pi(\gamma + (1-\gamma)r^*)/2r^*(1-\gamma)$

The next proposition shows the comparative statistics for optimal number of patents D^*.

Proposition 2

1. *D^* is an increasing function of r^**
2. *D^* is an increasing function of γ*
3. *D^* is a decreasing function of β*

If r^* increases, the profit from inessential patents also increases. Similarly, if the rate of essential

patents γ increases, firm 1 can easily obtain profit from patents. Then, firm 1 has an incentive to increase its number of patents. If the parameter of declaration cost β increases, firm 1 decreases its declaration rate. Then, it will decrease its R&D efforts.

5. Ex-post assessment

(1) Importance of declaration cost

From Lemma 2, we know that the over-declaration of SEPs is mitigated by using ex-post essentiality assessment. In this model, we ignored the implementation cost of ex-post assessment. If we take into account the implementation costs, we need to reduce such costs from the viewpoint of society. In order to reduce the cost, the declaration rate by firm 1 should be as low as possible. Lemma 3 says that the declaration rate is a decreasing function of the declaration cost. In that sense, it is important to make the declaration costly from the viewpoint of society.

(2) R&D incentives

Lemma 4 shows that the optimal number of patents is an increasing function of the declaration rate. In addition, Lemmas 1 and 2 show that ex-post assessment decreases the declaration rate. Then, we can easily show that ex-post assessment decreases firm 1's R&D efforts.

V. Conclusion

In this paper, we consider how ex-post assessment affects right holders' R&D and declaration rate. We close this paper by pointing out future extensions of this model. First, we assume that only firm 1 can choose its declaration rate. We need to consider multiple players who decide their declaration rate. However, the basic results of this paper will not change since ex-post assessment decreases the marginal revenue of declaration even if we consider a multi-player game. Second, firms can dispute other firms' declared patents. We need to consider the case where firm 1 can increase its profit share by over-declaration and decrease rival firms' profit share by disputes. If we consider this case, ex-post assessment affects firm 1's effort allocation. We will attempt to consider this problem in future research. Third, we consider that a firm declares its patents as SEPs to increase its profit share. However, right holders also have an incentive to secure the freedom to operate by over-declaration. We have to consider the case where firms attempt to secure FTO.