Punishment Mechanism Design of Infringement Behavior under the Patent System

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Abstract: That the infringers commit patent infringement behavior has low cost and high return. It costs a large amount of money when the patentees assert their rights. In addition, the observation degree of the government departments to the infringement behavior is not enough, and the punishment to the infringers doesn’t reach the expected effect. Owing to these reasons, the patent infringement behavior has not been controlled effectively. This paper, from the perspective of behavioral game, established a game model of the behavior punishment mechanism between the infringing party and the government regulator. The author quantitatively analyzed the utility of the infringement behavior which infringing party committed or not and solved the Nash equilibrium of the game model. Based on the study, the paper offered a basic theoretical frame for punishment mechanism design of patents infringement behavior, and provided a new way for government regulator to give a better supervision to the infringement behavior.

Keywords: patent system, infringement behavior, punishment mechanism

1 Introduction

In the new institutional economics research, we assumed that the market main body often had speculative psychology in the case of asymmetric information. They took advantage of others “rational” limited and did everything possible to hurt others in order to achieve their own utility maximization (Fan, 1992). Because the patent right is an intangible property right, its openness and profitability make itself more vulnerable to be infringed. Additionally, the infringement behavior has a certain degree of secrecy. For instance, in order to escape the legal responsibility, the infringing party did not fully realize each limited technique characteristics of the claims, but only realized part of technical characteristics or realized the rights respectively (Yuan, 2002). This is not conducive to the observation of the patents infringement behavior for government regulator. With the science development and the accelerated pace of informatization, more and more patent infringement cases appeared in people’s sight. According to the statistics, the State Intellectual Property Office (SIPO) entertained the patent infringement cases 1077 pieces, investigated fake patent cases 728 pieces in 2010 (SIPO, 2011). Therefore, that how to effectively restrain the patent infringement is the key of perfecting the patent protection system.

Recent years, a lot of scholars in and out of China undertook extensive research on the patent infringement behavior from various perspectives. Most scholars began research in terms of economics. Lu Fei (1995) thought established strong patent infringement punishment mechanism according to the actual situation is a basic ring of patent protection. Through the analysis of patent essence, the characteristics of the patent infringement behavior and its judicial restriction, Yuan Xiaoshuang (2004) proposed her own ideas on how to perfect the legal system to effectively restrict the behavior. Wang Xinhua (2011) discussed the functions and characteristics of the punitive damages system, analyzed its importance in fighting the infringement, and put forward the shortage and improvement suggestions of the punitive damage system. Roger etc (2005), Eric (2005) and other scholars from the law point studied the patent infringement. For example, the patentees’ compensation and license fees, the identification of infringers’ illegal profits. In addition, a few scholars established models and analyzed the patent infringement quantitatively. Crampes etc (2002) established static and dynamic game model to analyze the infringement occurrence frequency and the strategy selection of the patentees. James and Dennis (2006) examined the impact of patent infringement damages in an equilibrium oligopoly model, finally came to the conclusion that the infringement always occurred in equilibrium with the infringing firm making market choices that manipulate the resulting market profit of the patent holder.

Previous studies, from the perspective of law or economics, mainly analyzed the patent infringement behavior qualitatively. Only a few scholars analyzed the patent infringement behavior quantitatively. In view of these situations, the author gave some analysis to provide reference for the government department. From the

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point of the behavioral game theory, firstly, this paper established and analyzed the game model between the infringing party and government regulator, and got the critical condition which makes the patent infringement punishment mechanism valid. Then, through the solution and analysis of the expected return’s Nash equilibrium condition of the infringing party and regulator in the mixed strategy game model, the author concluded that the fundamental to solve the patent infringement is to increase the punishment strength on the basis of strengthening the regulator’s supervision. Additionally, in this paper, the infringing party is the general term of the social main body which is intended to infringe or has infringed yet.

2 Game Model of Behavior Punishment Mechanism

2.1 Basic assumption of the model

Regarding the patent infringement behavior, the characteristics of the existing institutional environment is that patent protection system is not perfect, the government regulatory supervision strength is too soft, infringement punishment strength is not enough. The paper, in the model, assumes that the institutional environment is strong institutional environment: the patent rights consciousness is strong; for the government regulator, the supervision strength is strong, the rate of detecting is high, and the punishment strength of the infringement is also strong.

The paper, for the convenience of analysis, set the two kinds of behaviors of the infringing party: non-infringement behavior \( a_i \) and infringement behavior \( a_i \). The non-infringement behavior \( a_i \) is an advocating behavior by Government regulator, while the infringement behavior \( a_i \) is a behavior to be detected and banned by Government regulator. In the paper, \( \text{C}(a_i) \) is the cost of the behavior \( a_i \) of the infringing party; \( \text{V}(a_i) \) is control returns of the behavior \( a_i \) of the infringing party from the regulatory authorities; \( \text{R}(a_i) \) is the natural return of the behavior \( a_i \) of the infringing party, \( i = 0,1 \).

As long as the behavior \( a_i \) happened, \( \text{C}(a_i) \) is the behavior cost. It is an inevitable event, so the probability of occurrence of behavior cost is 1.

When government regulator monitored the behavior \( a_i \) of the infringing party, it would definitely exert control return to infringing party. However, the control return \( \text{V}(a_i) \) happened with a certain probability \( p_i(a_i) \). Further more, when \( i = 0 \), infringing party gains control return \( \text{V}(a_0) \) with the probability \( p_i(a_i) \); when \( i = 1 \), government regulator exerts control return \( \text{V}(a_i) \) to infringing party with the probability \( p_i(a_i) \). In fact \( p_i(a_i) \) is the supervision strength to infringing party of government regulator.

Similarly, infringing party gains natural return \( \text{R}(a_i) \) with the probability \( p_i(a_i) \) : when infringing party selects behavior \( a_i \), it has the probability \( p_i(a_i) \) to gain natural benefit; when infringing party selects behavior \( a_i \), infringing party has the probability \( p_i(a_i) \) to gain natural benefit \( \text{R}(a_i) \).

2.2 Game theory of behavior punishment mechanism

In the game model of behavior punishment mechanism, the rule of the game between the infringing party and government regulator is described as follow.

From the perspective of the infringing party, its selection and performing actions need to pay corresponding cost. The paper assumed that non-infringement behavior’s cost was \( \text{C}(a_0) \) and infringement behavior’s cost was \( \text{C}(a_1) \).

The behavior selection of the infringing party would have two different results:

1. When infringing party selected the non-infringement behavior \( a_0 \), the probability government departments monitored infringement behavior was 0. At the same time, the infringing party had the probability \( p_i(a_0) \) to gain control return \( \text{V}(a_0) \) (such as credit, fame, etc, and \( \text{V}(a_0) > 0 \) ) and has the probability \( p_i(a_0) \) to gain natural return \( \text{R}(a_0) \).

2. When infringing party selected the infringement behavior \( a_1 \), the infringing party had the probability \( p_i(a_1) \) to gain control return \( \text{V}(a_1) \) from government regulator (namely the punishment after the infringement behavior had been found), and \( \text{V}(a_1) < 0 \).

From the perspective of the regulator, when it monitored the infringement behavior, once finding infringement behavior, it would punish the infringing party. The punishment strength was \(-\text{V}(a_i)\), which is a
random event and happen with the probability \( p(a_i) \leq 1 \). As long as the government regulator did not monitor the behavior \( a_i \), it would think the implementation behavior of infringing party were all \( a_0 \) and it did not carry on any punishment. Therefore, even if infringing party adopted the infringement behavior, but was not found, infringing party had the probability \( p(a_0) = 1 - p(a_1) \) to gain control return \( V(a_0) \). In addition, the government regulator monitoring the infringement behavior needed cost, known as the observation cost.

To sum up, the game rule of behavior punishment mechanism can intuitively express through the game tree (Sun Shaorong, 2006), shown in Figure 1. A is the infringing party; B is the government regulator; \( a_{0,1} \) means when behavior \( a_i \) happened, it cannot be monitored by government regulator; \( a_{1,1} \) means when behavior \( a_i \) happened, it can be monitored by government regulator.

![Figure 1: The game tree of the behavior punishment mechanism](image)

2.3 Validity analysis of game model of behavior punishment mechanism

2.3.1 The mathematical function of the infringement cost

When the infringing party considers that the expected return of the implementation of certain patent infringement exceeds benefits spending time and other resources on other activities, it may be engaged in the patent infringement behavior. Of course, the infringing party will also consider the possibility which such violations was observed, and punishment after being found (Zhu & Chen, 1999). The paper assumes \( C \) is the total cost after infringing party adopted infringement behavior \( a_i \), so the cost function is

\[
C = C(a_i) - p_i(a_i)V(a_i)
\]  

In equation (1), \( V(a_i) < 0 \). When infringing party’s return of infringement behavior is greater than the total cost, namely \( R(a_i) > C \) or \( R(a_i) - C > 0 \), the infringing party will adopt infringement behavior \( a_i \). In other words, the condition infringement behavior happened is the return is greater than cost. In fact, frequently, infringing party only need to invest less cost, it can earn huge profits.

2.3.2 The utility analysis of infringing party behavior selection

According to the principle of the game of the behavior punishment mechanism, we calculated the expected return of the infringing party behavior selection \( a_0 \) and \( a_1 \), and analyzed punishment mechanism of the model from the point of utility.

The infringing party expected return of non-infringement behavior \( a_0 \), namely the utility \( U(a_0) \) of non-infringement behavior \( a_0 \) is:

\[
U(a_0) = V(a_0) + p_i(a_0)R(a_0) - C(a_0)
\]  

The infringing party expected return of infringement behavior \( a_1 \), namely the utility \( U(a_1) \) of non-infringement behavior \( a_1 \) is:

\[
U(a_1) = p_1(a_1)R(a_1) - C(a_1) + p_1(a_1)V(a_1) + [1 - p_1(a_1)]V(a_0)
\]
The direct purpose of patent infringement is to obtain economic benefits. When \( U(a_0) > U(a_1) \), that is, the utility of non-infringement behavior is greater than the utility of infringement behavior, infringing party will abandon the infringement behavior and choose non-infringement behavior; when \( U(a_0) < U(a_1) \), that is, the utility of non-infringement behavior is less than the utility of infringement behavior, infringing party will adopt infringement behavior; when \( U(a_0) = U(a_1) \), both the income return is balanced, and whether adopting the infringement behavior depends on the individual of the infringing party's attitude towards risk.

From the above analysis it is easy to see making infringing party to choose advocating behavior must be content with:

\[
U(a_0) > U(a_1)
\]  

(4)

Considering equation (2)(3)(4) and simplify the formula:

\[
p_i(a_i) > \left[ p_i(a_i)R(a_i) - p_i(a_0)R(a_0) \right] + \left[ C(a_0) - C(a_i) \right] / V(a_0) - V(a_i)
\]

(5)

When the behavior punishment mechanism meet equation (5), the optimal choice of the infringing party is risk aversion and choosing non-infringement behavior, at this time, the mechanism is effective. And thus, the effectiveness of behavior punishment mechanism depends on the difference between the impact parameters of the two types of behavior choice of the infringing party and government regulator's supervision strength. The paper defines them respectively as follows. The difference between the expected natural return of the two types behavior choice is \( p_i(a_i)R(a_i) - p_i(a_0)R(a_0) \); the difference between the behavior costs of the two types behavior choice is \( C(a_0) - C(a_i) \); the difference between the Control return of the two types behavior choice is \( V(a_0) - V(a_i) \); Observation rate is \( p_i(a_i) \).

2.4 The strength design of behavior punishment mechanism

The necessary condition of effective for the Known infringement behavior’s punishment mechanism is:

\[
p_i(a_i) > \left[ p_i(a_i)R(a_i) - p_i(a_0)R(a_0) \right] + \left[ C(a_0) - C(a_i) \right] / V(a_0) - V(a_i)
\]

Namely:

\[
p_i(a_i)[V(a_0) - V(a_i)] > \left[ p_i(a_i)R(a_i) - p_i(a_0)R(a_0) \right] + \left[ C(a_0) - C(a_i) \right]
\]

(6)

So, the paper gets the institutional strength \( J \) of behavior punishment mechanism (Sun Shaorong, 2008) to measure the strength of the effectiveness of behavioral punishment mechanism. As follow:

\[
J = p_i(a_i)[V(a_0) - V(a_i)] - \left[ p_i(a_i)R(a_i) - p_i(a_0)R(a_0) \right] - \left[ C(a_0) - C(a_i) \right]
\]

(7)

In the model of behavior Punishment mechanism, we can measure its effectiveness by a simple calculation institutional strength. When \( J > 0 \), the institution is effective, and when \( J < 0 \), the institution is invalid. Only \( J > 0 \), the punishment mechanism can achieve the effect that infringing party adopt non-infringement behavior.

3 The Mixed Strategy Game Model between the Infringing Party and Government Regulator

In order to protect the patentees' rights and restrain the growth of the bad practice, the government department needs to take some supervision and punishment for the longstanding infringement phenomena. Due to the secrecy of the infringement behavior, regulators need to put into certain observation cost (including human, material and financial resources, etc.) to obtain the information which the infringing party committed infringement behavior or not. If regulators reduced the supervision for the reason of saving costs, the infringement probability would increase.
3.1 The pure strategy game model

Given some assumption: when no infringement behavior occurs, whether the regulator regulates or not, it will gain positive utility $M$ (given $M$ for constant; when infringement behavior occurs and the regulator investigates strictly, it will gain additional utility $m$ on the basis of positive utility $M$), which has the relationship with the patent infringement degree $\sigma$, we set $m = m(\sigma) > 0$; Given $C$ as observation cost of the regulator, and it is positively correlated with the supervision strength $\mu = p_r(a)$, that is to say the greater the supervision strength and the higher input cost, and set $C = C(\mu) \geq 0$; If the regulator did not regulate the infringement behavior, it would receive the punishment $P$ from the national, the punishment usually relates to the dereliction degree $\lambda$ of the regulator, and set $P = P(\lambda) \geq 0$.

We established a game model between the infringing party and the government regulator, as is shown in table 1. In the model, the infringing has two strategies: non-infringement $a_0$ and infringement $a_1$; the regulator also has two strategies: non-supervision $b_0$ and supervision $b_1$.

<table>
<thead>
<tr>
<th>Infringing Party</th>
<th>Regulator</th>
<th>$M$</th>
<th>$M - C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_0$</td>
<td>$p_r(a_0)R(a_0) + V(a_0) - C(a_0)$</td>
<td>$p_r(a_0)R(a_0) + V(a_0) - C(a_0)$</td>
<td></td>
</tr>
<tr>
<td>$a_1$</td>
<td>$-P$</td>
<td>$M + m - C$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$p_r(a_1)R(a_1) + V(a_1) - C(a_1)$</td>
<td>$p_r(a_1)R(a_1) + V(a_1) - C(a_1)$</td>
<td></td>
</tr>
</tbody>
</table>

3.2 Building the mixed strategy game model

Under the circumstance of the information asymmetry, the supervision probability of infringement varies as different supervision strength. And we assumed that when there exists infringement, as long as the regulator gives supervision, it can observe the infringement behavior with the probability $p_r(a)$, and then the probability which the infringement behavior can not be observed is $1 - p_r(a)$.

Likewise, not all of the infringing party will choose the infringement behavior. In the face of uncertainty income trading, for the conservatives of the risk aversion type, the probability of selecting infringement behavior is very small; and to the contrary, for adventure activists of the risk preference type, they often are willing to accept the risks, that is to say the probability of selecting infringement behavior is larger. Set $0 \leq q(a) \leq 1$ is the probability of the infringing party selecting the infringement behavior, then the probability of non-infringement behavior is $1 - q(a)$. Consequently, the author established a mixed strategy game model on the basis of pure strategy game model of the punishment mechanism, as is shown in table 2, A represents the infringing party and B represents the regulator.

<table>
<thead>
<tr>
<th>Probability</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_0$</td>
<td>$1 - q(a)$</td>
<td>$M$</td>
</tr>
<tr>
<td></td>
<td>$p_r(a_0)R(a_0) + V(a_0) - C(a_0)$</td>
<td>$p_r(a_0)R(a_0) + V(a_0) - C(a_0)$</td>
</tr>
<tr>
<td>$a_1$</td>
<td>$q(a)$</td>
<td>$-P$</td>
</tr>
<tr>
<td></td>
<td>$p_r(a_1)R(a_1) + V(a_1) - C(a_1)$</td>
<td>$p_r(a_1)R(a_1) + V(a_1) - C(a_1)$</td>
</tr>
</tbody>
</table>
Therefore, we calculate the expected return of the infringing party and the regulator respectively.
(1) Set the expected return of the infringing party as \( EU_a \), thus

\[
EU_a = [p(a_0)R(a_0)+V(a_0)-C(a_0)][1-q(a_1)]|1-p(a_1)| + [p(a_0)R(a_0)+V(a_0)
-C(a_0)][1-q(a_1)]p(a_1) + [p(a_1)R(a_1)+V(a_1)-C(a_1)][1-p(a_1)]q(a_1)

+ [p(a_1)R(a_1)+V(a_1)-C(a_1)]q(a_1)p(a_1)
\]

For the convenience of calculation, we set \( q = q(a_1), p = p(a_1), p_\alpha = p(a_1), p_\alpha = p(a_0), \) \( R_\alpha = R(a_0), R_\beta = R(a_1), V_0 = V(a_0), V_1 = V(a_1), C_0 = C(a_0), C_1 = C(a_1). \)

Then \( EU_a \) can be simplified as:

\[
EU_a = (R_\alpha p_\alpha + V_0 - C_0)(1-q)(1-p) + (R_\beta p_\beta + V_0 - C_0)(1-q)p + (R_\beta p_\beta + V_1 - C_1)(1-p)q

+ (R_\alpha p_\alpha + V_1 - C_1)pq
\]

The finishing equation is

\[
EU_a = (R_\alpha p_\alpha + V_0 - C_0) + (R_\beta p_\beta - R_\beta p_\alpha + C_0 - C_1)q + (V_1 - V_0)pq \tag{8}
\]

(2) Similarly, set the expected return of the regulator as \( EU_b \), thus

\[
EU_b = M(1-q)(1-p) + (M-C)(1-q)p + P(1-p)q + (M + m - C)pq
\]

The finishing equation is

\[
EU_b = [M - (M + P)q] - Cq + (M + m + P)pq \tag{9}
\]

In the equation (8) and (9), let

\[
\frac{\partial (EU_a)}{\partial q} = 0, \quad \frac{\partial (EU_b)}{\partial p} = 0,
\]

then

\[
p = \frac{(R_\beta p_\beta - R_\beta p_\alpha + C_0 - C_1)}{V_0 - V_1}
\]

and

\[
q^* = \frac{C}{M + m + P}
\]

\[
\left\{
\begin{array}{l}
p^* = \frac{[R(a_1) p_\beta (a_1) - R(a_0) p_\alpha (a_0)] + [C(a_0) - C(a_1)]}{V(a_0) - V(a_1)} \tag{10a}

q^* = \frac{C(\mu)}{M + m(\sigma) + P(\lambda)} \tag{10b}
\end{array}
\right.
\]

Formula (10) is the Nash equilibrium of mixed strategy game model. In the game model, the infringing party selected the infringement behavior with probability \( q \), and the regulator regulated the behavior with the supervision probability \( p^* \). In order to improve the validity of the behavior punishment mechanism, that is to increase system strength \( J \), we must try to make \( p(a_1) > p^* \). \( q(a_1) < q^* \).

In equation (10a), when the punishment to the infringing party increased, that is, increase the value of \( |V(a_1)| \) (usually the value of \( V(a_1) \) hasn’t changed a lot), the difference of \( V(a_0) - V(a_1) \) would increase. And assumed molecules \( (R_\beta p_\beta - R_\beta p_\alpha + C_0 - C_1) \) basically remain unchanged, in this situation, the supervision strength of the regulator would present \( p(a_1) < p^* \). In other words, when the punishment to the infringing party increased, regulators would deregulate the infringement behavior. Because of regulator’s neglect of duty, the infringing party would commit the infringement behavior without scruple. Obviously, the increase of the punishment strength could not restrain the infringement behavior fundamentally.

In equation (10b), each year the observation cost \( C(\mu) \) of the government for supervising the infringement behavior almost remained the same, \( M \) is a constant and \( m(\sigma) > 0 \), so when the punishment \( P(\lambda) \) to the regulator increased, the probability of the infringing party selecting the infringement behavior
would show $q(a_t) < q^\ast$. Obviously, when the punishment to the regulator increased, the regulator would improve their supervision strength to the infringement behavior. And once found the infringement, the regulator would exert negative control return $V(a_t)$ to the infringing party. Only in this way can we radically reduce the occurrence of the infringement behavior.

4 Conclusion

In the paper, mainly from the perspective of building and analysis of game model for behavior punishment mechanism, the paper provides a basic theoretical frame for the design of infringement behavior punishment mechanism, and find out necessary condition of the effectiveness of behavior punishment mechanism. The study not only provides a new way of thinking for government regulator to effectively supervision department effective regulatory to supervise infringement behavior, but also provides reference for the design of behavior punishment mechanism in other areas.

5 References