



BioTechnology

An Indian Journal

FULL PAPER

BTALJ, 8(10), 2013 [1425-1430]

Evolutionary game theory analysis of IPR infringement based on duplicative dynamic

Xue-feng he*, Bing-Zeng, Li-li Jiu

Accounting R&D Center Chongqing University of Technology Chongqing, (CHINA)

ABSTRACT

This thesis mainly analyses the strategies' choice on the interaction between the administrant government group and the intellectual property right (IPR) users group with the evolutionary game theory. A model of asymmetric game is set up by analyzing their respective costs and benefits, replicated dynamic model and differential equation stability theory are adopted as basic analytical tools. At the same time, the steady state of the monitoring infringement activity according to different values of parameters under bounded rationality is analysed. Simultaneously, how IPR users and supervisory administrations choose their respective strategies are explained and some policies and strategies about the establishment of a complete supervision and regulation system concerning IPR infringement are put forward.

© 2013 Trade Science Inc. - INDIA

KEYWORDS

Intellectual property right (IPR);
Infringement;
Evolutionary game;
Duplicative dynamic.

INTRODUCTION

With knowledge economy's approaching, intellectual property right (IPR) has been the core competencies and key factors for most enterprises to gain footholds. In contemporary society, IPR protection has become our countries' one national strategy. As a whole, our country, however, for a variety of historical reasons, began work on its IPR protection system at a comparatively late date. Since China followed the policy of reform and opening, it accelerated the process of establishing an IPR protection system and carried on its IPR legislation at a speed never before known. Especially after we joined WTO, our country made a comprehensive amendment on the correlative IPR laws, regulations and judicial interpretation, and enacted a series of new laws and regulations to perfect our sys-

tem. Simultaneously, measures to strengthen the legal framework for enforcement continue has been and being discussed, which formed a IPR protection model of parallel operation format of administrative and judicial protection.

As the IPR protection system in its modern form was established only for a short time, people's awareness of IPR protection remains underdeveloped in society at large. In some regions and governmental departments there is insufficient appreciation of the importance of IPR protection. To some extent, some serious acts of infringement have violated not only the legitimate rights and interests of the holder of IPR, but also the dignity of the law. Accordingly, IPR infringement has critically jeopardized market that facilitates fair competition, which make the infringement behaviour viewed by all administrators as "industrial plague" or

FULL PAPER

“underground economy”. IPR infringement in recent years has become a difficult problem in China.

The administrant government and enterprises are the main participants in the governance of IPR infringement. Whether the implementation of counterfeit and infringing act happens can be regarded as the result of the game between the two parties. Driven by utility maximization, the two play the game by strategies' choice. Thus, building a game model of tort supervision between governments and IRP users can better promulgate their strategies' changes in order to put forwards some effective policies and proposals to better govern IPR infringement behaviour.

Great attention has been attached to academia about game analysis on the government's measures against IPR infringement. Wu Jingye (2000) put forward the meanings of the striking strength to the counterfeit and inferior goods and frames the model of efficiently striking to the flooding of the counterfeit and inferior goods^[3]. Qiu Dongyang (2003) analyzed the game relationship between counterfeit and anti-counterfeit, pointed out “prisoners dilemma” and the motive game models of large and small companies in counterfeit^[4]. Ning Keqiang (2004) proposed some suggestions about governments' counter measure against counterfeit^[5]. Bai Xueqiu (2005) introduced the idea of outside interference to construct a partial adverse selection model based on the Akerlof's adverse selection theory,, which can reach the non-zero equilibrium of market within in finite times of trades^[6]. Liu Bin, Chen Qi (2005) analyzed infringement phenomenon from the game perspective, put forward three main factors including combat cost, forfeit amount and illegal turnover and the main cause was the poor correlation ship between forfeit amount and illegal turnover, in which the former for its insufficiency seldom exert the warning effect on the latter illegal practices^[7]. Although great academic achievements have pushed forward our IPR infringement supervision research scientifically, there are still existing certain imperfection about our administration system.

This paper mainly studies long-term evolution stability between the administrant government group and the intellectual property right(IPR) users group under the participator bounded rationality hypothesis. Meanwhile, the steady state under the hypothesis of both sides interconnecting and binding each other to end tort is

analysed. And at the end of thesis, the correlative conclusion has been arrived at.

EVOLUTIONARY GAME ANALYSIS

Asymmetric game model

Notoriously, Alcock (1989) has proposed that testing of evolutionary hypotheses is the focus of most research into animal behavior, especially by behavioral ecologists (Krebs and Davies 1991), who emphasize the functional significance of behavior, not just the descriptions dwelt on by earlier ethologists. These methods are only just beginning to be applied to the study of human behavior (Howard 1991; Barkow et al. 1992; Smith 1982)^[8]. To this day, evolutionary game dynamics is the application of population dynamical methods to game theory. It has been introduced by evolutionary biologists, anticipated in part by classical game theorists (Josef Hofbauer; Karl Sigmund, 2003).

The parties (the government supervisors and enterprises) both have two kinds of strategies: the supervisors can take strict or minor supervision strategy, while enterprises choose abidance or tort tactics appropriately against the corresponding supervision. As neither of them do selection simultaneously nor their strategic choices and profits are asymmetric, this paper put forward a relevant payoff matrix between the two participants by studying their behaviour choice procedure based on replicated dynamic equation using the asymmetric game model. On the basis of non-cooperative repeated game, TABLE 1 shows the mentioned payoff table:

TABLE 1 : Asymmetric game model between government supervisors and enterprises

Strategy		Governmental Regulators	
		Strict supervision (f_1)	Minor supervision ($1-f_1$)
Enterprises	Abidance (f_2)	S- K_1 , - G_1	S- K_1 , 0
	Tort ($1-f_2$)	- K_2 , K_2-G_1	0, - G

In TABLE 1, the monitoring cost of administrant government is G_1 . Governments can not implement an efficient supervision because of the cost limit, while execute the check action at a certain probability “ f_1 ”;

Meanwhile, if enterprises have a good sense of professional moral cultivation and legal literacy, they will choose abidance tactics whether the supervisors check them or not, which brings about loss of some illegal income “ K_1 ” and acquisition of reputation benefits “ S ”, which is with a probability of “ f_2 ”; Conversely, if enterprises are engaging in going after IPR infringement illegal benefits and profits, we define the huge penalty as “ K_2 ” along with a big loss of social image once they were discovered by administrators; Beyond that, if governments make their supervision a mere formality, yet enterprises neglect the risk of liability arising from tort as well, what all these produce are social cost as “ G_2 ” and negative returns for supervisors as “ G ”.

Game theory indicate that people do different selection and interact under the situation of diverse decision objective and constraint condition, finally to the formation of dynamic results of game between each economic entity and surroundings. One of the vital concepts is Nash Equilibrium (Noncooperative Equilibrium), which explains that both parties choose the self-best tactics instead of achieving collusion, ignoring any other social welfare and benefits of other opponents. This kind of strategy combination consists of combinations of all players’ best tactics.

It is more convincing to analyse the rationality of supervision degree on monitoring enterprises’ IPR infringement behaviour on the basis of Nash equilibrium theory. IPR infringement is becoming the most troubling large-scale companies’ problem in the world and increasing enterprises choose to violate others’ IPR owing not only to the bad attitudes of companies, but the minor supervision and penalization. And all these contributes the phenomenon of $G < G_1 - K_2$. By now, (Tort, Minor supervision) reaches a Nash equilibrium, and this is the particularly same as current situation, besides, which is what we urgently want to work out now.

The author tables a suggestion that the referred social cost “ G_2 ” should be born by the regulators. Normally, the negative returns caused by social cost “ G_2 ” is far more than the regulatory agencies’ monitoring cost “ G_1 ”, like $G_2 > G_1 > G_1 - K_2$. Through this method, regulators will be promoted to increase monitoring efforts to warn most enterprises to avoid involving into the vortex of IPR infringement. In such circumstance, the

asymmetric game model between both sides is depicted in the following table:

TABLE 2 : Payoff matrix between government supervisors and enterprises under a asymmetric game model

		Governmental Regulators	
		Strict supervision (f_1)	Minor supervision ($1-f_1$)
Enterprises	Abidance(y)	$S - K_1, -G_1$	$S - K_1, 0$
	Tort($1-y$)	$-K_2, K_2 - G_1$	$0, -G_2 - G$

Evolutionary analysis

The two important concepts of game theory are Evolutionarily Stable Strategy (short for ESS) and Replicated dynamic equation. Game theory aims at studying players’ strategy choice and equilibrium. Most people always take actions by intuition or imitating other success stories under the bounded rationality condition when they’re confronted with complicated problems, which is a continuous process of seeking and studying for the initial strategy may not be the best one. In the process, the proportion of high-profit strategy groups keeps arising until it comes to ESS. In all ESS strategy is such an effective way to resist aggression.

As all know that replicated dynamic equation describes adopt rate of a given strategy in a group. If the profit of the certain strategy is higher than group’s average revenue, more players tend to imitate, study and develop it. The survival of fittest is performed as a change rate $dx/dt > 0$. The referred differential equation is: $dx/dt = xk[u(k, s) - u(s, s)]$, xk represents the adoption ratio of strategy k , $u(k, s)$ is the expected revenue of strategy k , $u(s, s)$ means the group’s average revenue and k represents different strategies.

According TABLE 2, we calculate the enterprises’ replicated dynamic equation for the action of IPR infringement with a probability of f_2 :

$$F(f_2) = \frac{df_2}{dt} = f_2(1 - f_2)(S - K_1 + K_2f_1) \tag{1}$$

Make $\frac{df_2}{dt} = 0$, we get

$$f_{21}^* = 0, f_{22}^* = 1, f_1^* = \frac{K_1 - S}{K_2}$$

In accordance with the stability theorem of differ-

FULL PAPER

ential equation and nature of ESS, when there is $F'(f_2^*) < 0$, f_2^* is the evolutionary stable strategy. The following chart respectively shows different dynamic tendency in different situations.

When $f_1^* = \frac{K_1 - S}{K_2}$, $F(f_2)$ gets to be 0 consistently and we can consider it as this: as soon as regula-

tors' supervision arrives at f_1^* , the initial proportion of the attitudes(abidance or tort) of enterprises is stable. Realistically, it is of no difference for administrators to adopt minor or strict supervision.

When $f_1 < f_1^*$, there always exists $F(f_2) < 0$ in section (0, 1) and replicated dynamic equation (1) gets two balance points: $f_{21}^* = 0$, $f_{22}^* = 1$, which leads to

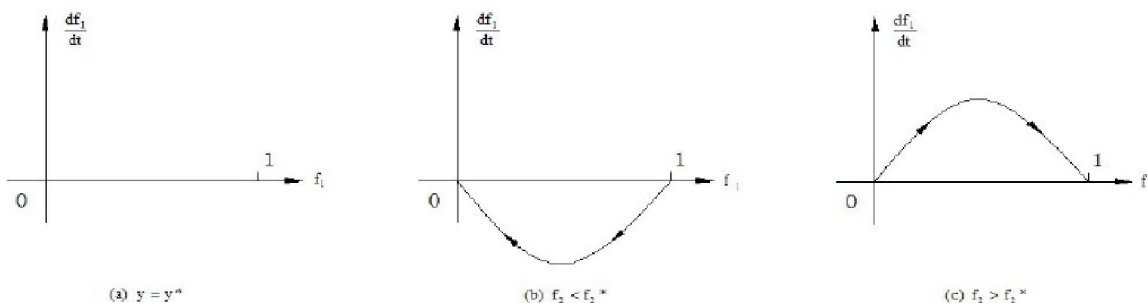


Chart 1 : Replicated dynamic phase diagram of enterprises in asymmetric game model

$F'(0) < 0, F'(1) > 0$. That means when $f_1 < f_1^*$, $f_{21}^* = 0$ is the single ESS as a whole. It is noted that once the governmental supervisors take weak inspection on the opposite side's behaviour, the possibility of enterprises' IPR torting keeps descending.

When $f_1 > f_1^*$, $F(f_2) > 0$ in section (0, 1) and replicated dynamic equation (1) still gets two balance points: $f_{21}^* = 0, f_{22}^* = 1$, contemporaneously $F'(0) > 0, F'(1) < 0$. Then when there is $f_1 > f_1^*$, $f_{22}^* = 1$ is the only evolutionary stable strategy(ESS) overall situation. We explain it as this: the supervisors interact well

with quoted companies, which attains Pareto Optimality gradually.

Similarly, the regulatory side and their replicated dynamic equation comes as:

$$G(f_1) = \frac{df_1}{dt} = f_1(1 - f_1)[(K_2 + G + G_2 - G_1) - (K_2 + G + G_2)f_2] \quad (2)$$

Make $\frac{df_1}{dt} = 0$, we get

$$f_{11}^* = 0, f_{12}^* = 1, f_2^* = 1 - \frac{G_1}{G_2 + G + K_2}$$

To further illustrate this kind of dynamic tendency, there comes Chart 2:

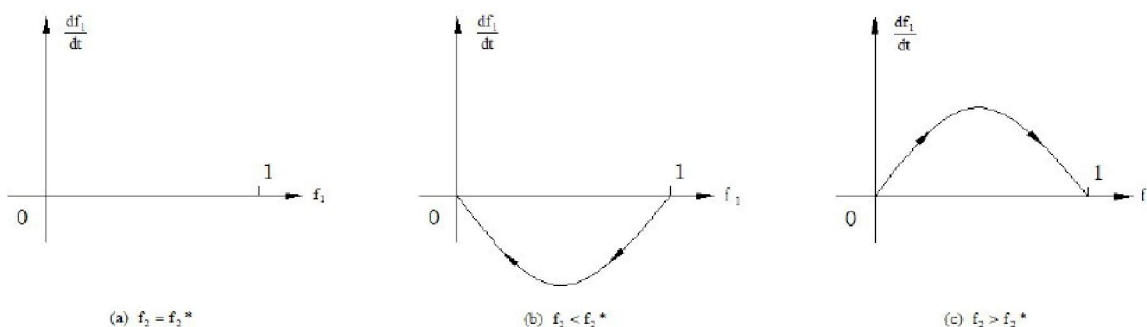


Chart 2 : Replicated dynamic phase diagram of enterprises in asymmetric game model

When $f_2^* = 1 - \frac{G_1}{G_2 + G + K_2}$, $G(f_1)$ always keeps

0. Behaviours of infringement do not exist in groups of

IPR users, which means when seriousness of attention in TABLE 2 comes up to y^* , it is stable for regulators to monitor.

While $f_2 > f_2^*$, $G(x) > 0$ in section (0, 1), which

arouses equation (2) to get balance points of $f_{11}^* = 0$, $f_{12}^* = 1$, simultaneously $G'(0) > 0$, $G'(1) < 0$, $f_{12}^* = 1$ gets to be the ESS. It is said that regulators will play a great role in supervision under such situation of both parties' carrying on perfectly, which definitely achieves Pareto Optimality gradually.

When $f_2 < f_2^*$, for the same reason, $f_{11}^* = 0$ proves to be the ESS. So to speak, enterprises' poor behaviours of torting IPR, combined with the other side's minor supervision and ignorance of the huge loss, creates an enormous adverse impact on our society.

CONCLUSIONS

To the intellectual property right users group, with K_1 magnifying S increases and K_2 diminishes. Supposing that companies are full of professional morality and legal culture, they would never tout whatever how the supervision administration act. So we can get a bigger reputation benefits S and a lesser illegal income K_1 ($S > K_1$), which gives rise to a smaller negative effect E .

Conversely, to regulators, if monitoring cost " G_1 " keeps increasing, then f_2^* decreases. In other words, these enterprises will take no account by degrees of the legality of their action on the IPR use; In addition, if G_2 and G grow in number of quantity, then f_2^* decreases, as well it can be interpreted as supervisors endure more with the incremental expectation of the public, which results in the government side enhancing supervision and the opposite side making up their mind in accordance with regulators: supposing that $f_1 > f_1^*$, it is a best choice for enterprises to abide, which generates $f_2^* > 0$; Last but not least, in the event of K_2 increasing, f_2^* magnifies, that is to say in case the punishment on the IPR infringement, it is not necessary for enterprises to run a risk abusing.

In summary, the formation of IPR users' infringement lies mainly in subjective and objective environments and conditions. Commonly, our countries' securities supervision institution has not implemented enough investigation, which can not overawe enterprises as cost of law-breaking exceeds illegal benefits. A large number of living tort examples have brought us a wake-up call, and blocking the "black hole" of insufficient IPR

protection is such a pressing thing that we can not wait. The following are some suggestions about how to prevent China's companies' IPR tort to protect the rights and interests of the relevant parties.

Reduce the governments' supervision cost and strenghten penalties for enterprises' IPR tort, and guide our intellectual property rights people lower the tortious enterprises' illegal income. Educate customers to purchase quality goods to lessen tortious enterprises' profits at the source.

Perfect the laws, rules and regulations about IPR infringement supervision, make a serious of manipulative accounting provisions to help administration build reputation to awe the companies which is up to tort.

Make all-round effort to strengthen protection of intellectual property right in the fields of legislation, law enforcement, legal procedures and mechanism in accordance with the 2007 Action Plan on Protection of Intellectual Property Right of China^[12].

Adopt and open court trial system on intellectual protection cases, and invite deputies to the People's Congress and member of the Chinese People's Political Consultative Conference (CPPCC) and representatives from industrial associations and relevant departments, as well as foreign governments and offices of international organisations to be auditors at court trials in China in order to increase transparency of judicial work on China's efforts in protection of intellectual property right^[12].

Strengthen the internal control and the leaders' awareness to guarantee the validity of IPR protection.

REFERENCES

- [1] Ye Qiang, Li Qiangui; On the Government. sM easure s aga inst Trademark Infr ingement Based on an Evolut ionaryGameModel. Chinese Public Administration., (12), (2009).
- [2] Zha Zhijie, Lin Yuanqing; Evolutionary Game Theory Analysis of Intellectual Property Right Management under Bounded rationality. Science Technology and Industry., (1), (2007).
- [3] Wu Jingye, Liu Hongbo; Analysis of Effect of Fighting Against Counterfeit and Inferior Goods. Journal of University of Electronic Science and Technology of China., (1), (2000).
- [4] Qiu Dongyang, Meng Weidong. Economics and

FULL PAPER

- Game Analysis on Counterfeit and Anti-Counterfeit. Commercial Research., (17), (2003).
- [5] Ning Keqiang, Wu Qingping, Li Xianzhong; Analysis of the government's counter measure Against Counterfeit. Economic Tribune. (21), (2004).
- [6] Bai Xueqiu; Outside Interference and Partial Adverse Selection: On Local Protectionism and Persistence of Counterfeits. Contemporary Finance & Economics., (2), (2005).
- [7] Liu Bin, Chen Qi. On Combating Counterfeit Trademarks. Commercial Research., (13), (2005).
- [8] Isaac M. Marks, Randolph M. Nesse; Fear and Fitness: An Evolutionary Analysis of Anxiety Disorders. ScienceDirect. Ethology and Sociobiology, <http://www.sciencedirect.com/science/journal/01623095/15/5>.
- [9] Chen Yan-jun, Tian Shuang-liang; Evolutionary Game Analysis of Food Safety Administration Based on Duplicative Dynamic, Science Mosaic, (6), (2010).
- [10] Li Shu-xiang, Liang Qiao-zhuan, Wu Yong; Evolutionary Game Analysis between Custom Inspector and Smuggler", OPERATIONS RESEARCH AND MANAGEMENT SCIENCE, 10(5), (2009).
- [11] Josef Hofbauer; Karl Sigmund. Evolutionary game dynamics. Bull. Amer. Math. Soc., 40, 479-519 (2003).
- [12] Protection of intellectual property right to be accelerated this year. World Manufacturing Engineering & Market., (4), (2007).