

Impact of TNCs patents activities on Domestic Enterprises' Innovation—Evolutionary Game Theory Approach

ZHANG Yong¹

¹Institute of quality Economic Research. China Jiliang University, Email: zhfk@cjlu.edu.cn.

DONG Hui Ting², ZHAO Jian Nan², LIANG He^{3*}

²China Jiliang University

³City college of Zhejiang University

Abstract— This paper has constructed a patent evolutionary game model of TNCs and domestic enterprises in the R&D activities decision-making process. In fact, it is a gaming process for domestic enterprises to choose the innovation behavior. Under the assumption of bounded rationality, and analysis the internal mechanism of enterprises innovation strategy pattern from the microscopic theory. At last, we provide some references recommendations for enterprises to make innovation decisions, for government to optimize allocation of market resources and thus to regulate the independent innovation behavior of the entire market more effectively.

Index Terms—TNCs; enterprise innovation; bounded rationality; evolutionary game

I. INTRODUCTION

Since Mac Dougall rose the issues of FDI spillovers, Scholars have do a lot of theoretical and empirical research on technology spillover of FDI.[1] Theoretical studies generally believe that FDI spillover within one industry mainly derive from demonstration and imitation effect, staff mobility effect and competition effect, while FDI spillover between industries are mainly from the before and after correlation effects. In empirical aspects of early study, Caves was the representative one which thought FDI had positive spillover to host corporate.[2] While Ai-Tken thought FDI had negative spillover to host corporate.[3] Gorg etc. investigated relevant research of spillover effects of the FDI within an industry, they Explained the phenomenon of negative spillover of FDI through some factors, such as absorption capacity, geographic dimension, vertical correlation, wage spillage and exports overflow. [4] Study of Crespo etc. suggests that it is the factors such as absorptive capacity and technology gap, geographic effect, characteristics of domestic enterprise and FDI characteristics that influence FDI technology spillover.[5] These literates laid the foundation for study on the impact of Transnational Corporations (hereinafter referred to TNCs) on the host country' technological innovation. Some scholars have

begun specific research into technology spillover effect of TNCs technical activities on the host country. Todo etc. found that only in R & D and training of multinational subsidiaries have positive spillover on the productivity of host country. [6-8] Marin etc. thought that only when TNCs engaged in intellectual creation and technical activities, will they have positive spillover on the host country.[9] Therefore, a model Centered in subsidiary is put forward to prove the view by using the data of Argentina and Brazil.

Domestic scholars have also do many special study on Chinese patent activity against TNCs technology spillover Liu Yun etc. found that TNCs patent applications in China have a positive impact on technology introduction, digestion and absorption and innovation of domestic enterprises and they have obvious alternatives and competition with domestic patent applications. [10] Li Ping etc. made the point that TNCs patent applications in China produced a technology spillover, but the spillover effects huge variations between regions, regional human capital, R & D investment levels, and regional differences in geography are the important factors affecting technology spillovers.[12] Xian Guoming, etc. They think TNCs patent applied quantity has positive effects on the innovation capacity of Chinese domestic-funded enterprises, at The same time, TNCs research activities will promote the innovation of domestic enterprises in industries which technology gap are smaller. [11] Zhang Chuanjie etc. studies based on the industry data and found that TNCs technology spillover promoted the increasing number of Chinese enterprises patent through competition and demonstration effects to some extent. [13] But TNCs monopoly on high-end technology hinders the improvement of the patents quality of Chinese enterprises.

The existing literature have investigated TNCs technology spillover on the host country from different angles, including FDI technology spillover and its influencing factors, spillover effect of TNCs R&D activities and impact of TNCs patent activity on the technological innovation of domestic companies and so on. In fact, studies about impact of direct technology

Corresponding author: Liang He
Email: liangh@zucc.edu.cn.

introduction (i.e. direct purchase of patents) on domestic enterprises patents innovations are less. In this paper, we will study from the perspective of evolutionary game' use direct technology introduction as an entry point, thus analysis the internal mechanism of innovation strategy choice of domestic enterprises in the contest with TNCs patent strategy from the micro perspective, and Provide some reference suggestions to domestic enterprises to make innovate decisions, government to optimize market allocation of resources and How to regulate the behavior of the entire market innovation more effectively.

II.TNCs STRATEGY GAME ON PATENTED DESIGN

TABLE I.
THE "BOXED PIGS" GAME BETWEEN MULTINATIONAL CORPORATIONS AND LOCAL ENTERPRISE IN PATENT INNOVATION AND IMITATION

		Multinational corporation A	
		Innovation	Imitation
Small and medium-sized Enterprise B	Innovation	5,1	4,2
	Imitation	6,0	0,0

As can be seen, the ideal state to research is multinational corporations and local enterprises carry through technical innovation at the same time, input one unit cost to each company. Driven by the great market demand, A choices to alone finish the technological innovation and obtain four units revenues, but for enterprise B, don't take part in innovation process and makes no influence to return, so it picked a "free ride", in what would be called "the Intelligent pigs", the result of the game is multinational corporation A has to do the technical research and development and the innovation by itself, while, the small, local business B picked a "free ride". As a generally accepted way, such cases often happen in enterprises where large scale gaps exist, but, the premise of success is a distinct between the product grade of large and small enterprises. Large enterprises gain handsome profit by provide superior products from

A. *Boxed pigs game in patent innovation and imitation*

The innovation and imitation in patent technology involved many companies foreign and domestic enterprises, a division has emerged between "big pig" and "pig" due to the different among Ln-scale portfolio and functional requirement. Now imagine there's one global enterprise A and one small, local businesses B, two units are required to do the patent technology for finishing two companies' similar products, after standardization for information brings 6 units income to multinational corporations A and two units to local enterprise B. The game analysis process is as shown in table 1.

high end market, no directly conflict means non market repeating between large and small enterprises as far as possible .

B. *Chicken game in patent innovation and imitation*

Assuming the two companies A, C, who have similar in size, in strength, in products and even in the large number of technology needs, facing to the similar game with chicken game about avoiding duplicate effort on the problem of technological innovation. Four units cost needs to finish the research of two companies' common technology in the technology innovations process. Technology innovation brings five units to each company; if two companies do similar patent research, all obtain zero net incomes. The game analysis process is as shown in tab.2.

TABLE II.
THE CHICKEN GAME BETWEEN MULTINATIONAL CORPORATIONS AND LOCAL ENTERPRISE IN PATENT INNOVATION AND IMITATION

		Multinational corporation A	
		R&D innovation	No development
Local large enterprise C	R&D innovation	3,3	1,5
	No development	5,1	0,0

So, to make productivity obtain excellent results reasonably and avoid duplicate construction, cooperation strategy is the best for them. The enterprise C will share others patents when firm A making its research and development. If C carries on the technical research and development in related area, enterprise also will share its patents. In this case, both sides have a certain lose, if A makes R&D innovation, enterprise C will try to share patents, sometimes they need to pay a high fee for patent pool. However, it's hard to reach cross company

cooperation on the patent technology R&D matter, it referred to the obstacles of firms with complex system.

C. *Prisoner's Dilemma game in patent innovation and imitation*

The company products of A and C need using similar technology in common area, as saving cost, two companies should joint research and development. Without greater conditions and reasonable fee allocation mechanism, the research results of A or C may be get by

each other at a lower price than the R&D costs. Produce the following analysis game (as shown in tab.3).

TABLE III.
THE ANALYSIS GAME BETWEEN TWO COMPANIES WHICH ARE JOINT RESEARCH AND DEVELOPMENT

		Multinational corporation A	
		R&D innovation	No development
Local large enterprise C	R&D innovation	1,1	-1,3
	No development	3,-1	0,0

And thus every company will place self-interest in highest priority when they could get relative patent technology at below cost without conduct R&D. (1) If company choices to do conduct R&D, he has to pay a high price for research and development and enterprise B can face higher patent sharing fees, but which is a problem to accept for them; (2) Although carries on the technical research and development in other domains and the patent resource share could be avoided, the cost is still high. (3) It's hard to recover the cost when A choices to do research alone and close patent technology. Therefore, the analysis result of this game is two companies all choice to do nothing.

D. Cooperate game is constructed under the leadership of government between multinational companies and native business enterprises

A complete information dynamic game model is used to analyze the game among government、local enterprises and multinational companies. Let's assume government plays a role in the coordination of technology research between local enterprises and multinational companies just for improving social Pareto. Multinational companies and local companies are rational market participants, they have business information about the other party, but their actions usually follow a sequential order and they could choose behaviors of their own on the premise that learning the government's attitudes and opinions. Now, given a game tree models to analysis (the first number for government, the second number for multinational companies and the third number for local enterprises).Game order as follows: (1) Government begin with making sound policy that encourage enterprises to conduct R&D and promote the cooperation between the two sides or not; (2) Regardless of the government's policy, multinational companies and local companies all can choose to cooperate or not.(As shown in Fig. 1)

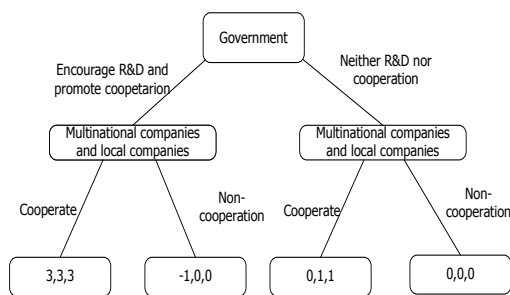


Figure1. The game among government, local enterprises and multinational companies

And thus multinational companies and local companies all choose cooperate in the social game with government guidance, to an all-winning situation, all pay for 3; When government encourage R&D and cooperation, but enterprises refusal to cooperate, thus increasing the research costs and don't developing new things, while, the government must put a lot of effort into the developing of technology research, expenditure is minus one, however, multinational companies and local companies is zero. Government doesn't encourage R&D and cooperation, the cooperation cost between multinational companies and local companies is much higher, even they cooperative R&D, each should pay one. If enterprises don't cooperate in R&D, they will refuse to do research, because they have to pay a large amount of research cost alone, so their cost is zero and the cost of government is same, government has no policy for their research. It was concluded that government to conduct, encourage and take part in the R&D is the condition to reach "Nash balance". So government realized Pareto Improving, multinational companies and local companies reached to R&D cooperative with a low cost and provided a strong guarantee for interests of the other parties involved due to strong government commitment.

Tactful equilibrium, under limited rational condition, is the result of adjusted after learning between each player, rather than of a one-time choice. Therefore, unlike the traditional game analysis, the core of evolved gambling analysis is not the best strategic options but the process of tactics adjustment, evolutionary trend and stability of group members which is composed of bounded rational gambling sides.

III. MODELS

When TNCs apply for patents in the host country, on the one hand, TNCs will have a positive spillover to the host countries through the demonstration and replication effects, but the technology gap between TNCs and local enterprises and the absorption capacity of local enterprises will affect the play of the effect, thus affecting the level of technology spillover. On the other hand, TNCs may compete with domestic enterprises in both technology market and product market, they will have a spillover to the host country by competitive effects, but the spillover effects can not only be positive but also negative, and The degree of competition between TNCs and domestic enterprises will affect the play of competitive effects, thus affect the degree of spillover. These two kinds of effects decided technology spillover effect of TNCs on domestic enterprises jointly, thus

affecting the behavior of domestic enterprises patent innovations. The framework of technology spillover for TNCs patent activity on domestic enterprises is shown in Fig. 2.

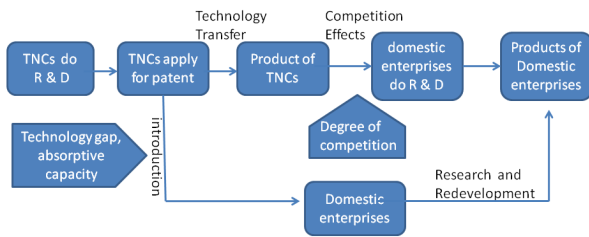


Figure2 the framework of technology spillover for TNCs patent activity on domestic enterprises

Since joint ventures involve more complex interest relations, In order to simplify the analysis necessarily, we do not intend to discuss the issue of joint ventures. So in this article, "TNCs" refers specifically to foreign-owned enterprises in China, and "domestic enterprises" refers specifically to enterprises which are entirely controlled by Chinese. Since what we consider is the direct introduction of patent, therefore, we assume that patent strategy of domestic enterprises and TNCs are only two in our model, namely, independent patent R&D and patent introduction.

Under conditions of limited rationality, the strategy equilibrium between Game parties is often the result of learning to adjust, not the result of a one-time choice. It compares human economic activity and competitive economic behavior analogy with biological evolution, and studies the balance of human economic behavior strategies and behaviors, as well as adjustments to the equilibrium state, nature and process of convergence. Therefore, the core of evolutionary game analysis is not the optimal policy choice of game parties, but the strategy adjustment process, trends and stability of group Members composed of bounded rationality game parties, which is different from traditional game analysis. It is these characteristics that make evolutionary game exhibited a strong ability in the interpretation of various social-economic phenomena. Evolutionary game contains the following assumptions:

A. Basic assumptions

(1) Bounded rationality. Actually, each game happens between one member of the former group and another one of the latter group. That is to say , we select one member from each groups randomly and repeatedly,then made the two members in pairs in a game.

(2) Incomplete information. Each enterprise is at the conditions under incomplete information, they do not know the type of themselves, and the participants may change in learning process and strategies adjustment.

(3) Myopia. Game parties' Learning and imitation strategy are limited inside the group which they are located. The adjustment mechanism of strategies is replication dynamic.

B. Construction of the model

Based on the above assumptions, in a particular industry, multinational company A and domestic enterprise B produce homogeneous products and compete with each other. In the initial state, the entire industry is in a relatively balanced status, and if Companies do not make patent R & D, the current daily production will not be affected. That is to say, the initial state of excess profits of enterprises of both sides is 0. in order to reap excessive profits now, Companies should make a choice about patent research and development decisions. Assuming that each enterprise has two choices of patent strategy, one is initiative research and development, the other is introduction. Because of a variety of uncertainties, there is a certain risk for enterprises to carry out a patent R & D. After introducing patent, enterprises may not be able to success for various reasons.

In a patent strategic decision, Assuming that, for multinational company A, the probability of success for Patent R & D is k_1 , the additional revenue created by a successful R & D is v_1 , The probability of success after the introduction is r_1 , the additional revenue created by The successful introduction is u_1 , the costs of R & D investment is d_1 ; for domestic enterprise B, The probability of success for independent R&D is k_2 , the additional revenue created by a successful R&D is v_2 , The probability of success after the introduction is r_2 , the additional revenue created by The successful introduction is u_2 , the costs of R&D investment is d_2 . If a company decides to introduce a patent, then the company should pay a patent fee c to another company (of course, its patent R&D is successful). If the two companies both take a negative patent strategy, a strategy that is not to do R&D, Then social production will sliding into a depression state, the two companies can only maintain normal production in the short term, additional benefits are both 0. Based on the above assumptions, multinational company A and domestic enterprise B, In case of taking different patent strategies, the payoff matrix of multinational company A and domestic enterprise B is as follows:

TABLE IV. THE PAYOFF MATRIX OF MULTINATIONAL COMPANY A AND DOMESTIC ENTERPRISE B

A \ B	Initiative R&D	Introduction
Initiative R&D	$k_1v_1-d_1, k_2v_2-d_2$	$k_1v_1+k_1c-d_1, r_2u_2-c$
Introduction	$r_1u_1-c, k_2v_2+k_2c-d_2$	0, 0

It is easy to see that this model is an asymmetric game. Assuming in a patent strategy, within the TNCs group, the proportion of choosing to make initiative R&D is p , the proportion of choosing to make introduction decision is $1-p$; within the domestic enterprises group, the proportion of choosing to make initiative R&D is q , the proportion of choosing to make a introduction decision is $1-q$. For TNCs group, the hybrid strategy of initiative R&D and the introduction is $P = \{p, 1 - p\}$; For the domestic enterprises group, the hybrid strategy of initiative R&D and the introduction is $Q = \{q, 1 - q\}$.

As we can see from the above payoff matrix, for multinational company A, $UA1$ is the expected benefit of

R&D, UA_2 is the expected benefit of introduction is, UA is the average benefit of the group, they are follows:

$$UA_1 = k_1 v_1 - d_1 + (1-q)k_1 c \quad (1)$$

$$UA_2 = q(r_1 u_1 - c) \quad (2)$$

$$UA = pUA_1 + (1-p)UA_2 = p[k_1 v_1 - d_1 + (1-q)k_1 c] + (1-p)q(r_1 u_1 - c) \quad (3)$$

Similarly, for domestic enterprise B, UB_1 is the expected benefit of R&D, UB_2 is the expected benefit of introduction is, UB is the average benefit of the group, and they are follows:

$$UB_1 = k_2 v_2 - d_2 + (1-p)k_2 c \quad (4)$$

$$UB_2 = p(r_2 u_2 - c) \quad (5)$$

$$UB = qUB_1 + (1-q)UB_2 = q[k_2 v_2 - d_2 + (1-p)k_2 c] + p(1-q)(r_2 u_2 - c) \quad (6)$$

For TNCs group where company A locates, the replication dynamic differential equation is:

$$F_1 = dp/dt = p(UA_1 - UA) = p(1-p)[k_1 v_1 - d_1 + k_1 c - q(k_1 c + r_1 u_1 - c)] \quad (7)$$

For domestic enterprise group where company B locates, the replication dynamic differential equation is:

$$F_2 = dq/dt = q(UB_1 - UB) = q(1-q)[k_2 v_2 - d_2 + k_2 c - p(k_2 c + r_2 u_2 - c)] \quad (8)$$

Consider equation(1),we make partial derivative of p,

$$F_1'(p) = (1-2p)[k_1 v_1 - d_1 + k_1 c - q(k_1 c + r_1 u_1 - c)] \quad (9)$$

in equation(2), we make partial derivative of q,

$$F_2'(q) = (1-2q)[k_2 v_2 - d_2 + k_2 c - p(k_2 c + r_2 u_2 - c)] \quad (10)$$

Now we set $dp/dt=0$; $dq/dt=0$,then we get:

$$p^* = (k_2 v_2 - d_2 + k_2 c) / (k_2 c + r_2 u_2 - c);$$

$$q^* = (k_1 v_1 - d_1 + k_1 c) / (k_1 c + r_1 u_1 - c).$$

In the plane $M = \{(p,q)|0 < p, q < 1\}$, there are 5 equilibrium points of this evolutionary game: $(0,0), (0,1), (1,0), (1,1)$ and (p^*, q^*) . From the characteristic value of Jacobi matrix of these equilibrium points, we can tell that (p^*, q^*) is a saddle point. According to the nature of evolution stability, a steady state can be called evolutionary stable strategy (ESS) if it is robust to a small disturbance. That is to say, As a ESS point p^* , in addition to the state that itself must be a balance point, it also must have the property that if some game players deviate from it because of some accidental errors, the replication dynamic will still make p return to p^* . Mathematically, this is equivalent to require $dp/dt = F_1(p)$ must be greater than zero, when a disturbance occurs and make p less than p^* ; and $F_1(p)$ must be less than zero ;when a disturbance occurs and make p greater than p^* . In other words, $F_1'(p^*)$ must be less than zero at these steady state. This is the "stability theorem" of differential equations. Represent these by the phase diagram of replicator dynamics equations; we can see that the point where it intersects the horizontal axis and at that point the tangent slope is negative is the ESS of the corresponding game replication dynamic.

Considering replication dynamic equation of TNCs groups where company A locates, the stability of each equilibrium point under different circumstances is as follows:

- (1) When $q = (k_2 v_2 - d_2 + k_2 c) / (k_2 c + r_2 u_2 - c)$, dp/dt is constant equal to 0, that is, p does not change with time, and on any level it is stable.
- (2) When $0 < q < (k_2 v_2 - d_2 + k_2 c) / (k_2 c + r_2 u_2 - c)$,

- ① If $p = 0$, $df_1 / dp > 0$, so that $p = 0$ is not the ESS

- ② if $p = 1, df_1 / dp < 0$, so that $p = 1$ is the ESS

- (3) When $(k_2 v_2 - d_2 + k_2 c) / (k_2 c + r_2 u_2 - c) < q < 1$

- ① If $p = 0$, $df_1 / dp < 0$, so that $p = 0$ is the ESS

- ② If $p = 1$, $df_1 / dp > 0$, so that $p = 1$ is not the ESS

The phase diagram of Fig.3 shows the dynamic trend and stability of p.

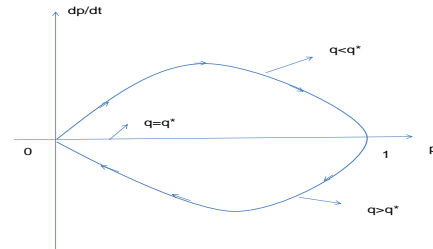


Figure3.Replication dynamic trend and stability of TNCs groups

Similarly, considering replication dynamic equation of domestic enterprises groups where company B locates, the stability of each equilibrium point under different circumstances is as follows:

- (1) When $p = p^* = (k_2 v_2 - d_2 + k_2 c) / (k_2 c + r_2 u_2 - c)$, dq/dt constant equal to 0, that is, q does not change with time, on any level it is stable.
- (2) When $0 < p < p^*$

- ① If $q = 0$, $dF_2 / dq > 0$, so that $q = 0$ is not the ESS

- ② If $q = 1$, $dF_2 / dq < 0$, so that $q = 1$ is the ESS

- (3) When $p > p^*$

- ① If $q = 0$, $dF_2 / dq < 0$, so that $q = 0$ is the ESS

- ② If $q = 1$, $dF_2 / dq > 0$, so that $q = 1$ is not the ESS

The phase diagram of Fig.4 shows the dynamic trend and stability of q.

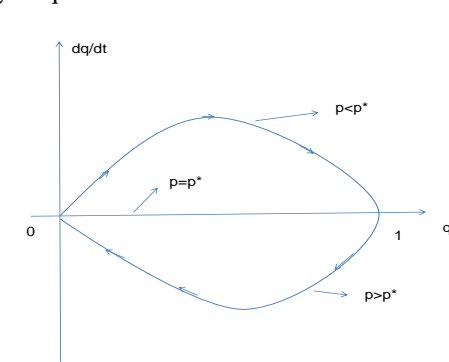


Figure 4.Replication dynamic trend and stability of domestic enterprises group

Furthermore, we use p and q to set the X, Y coordinates, and put the replication dynamic relationship of the two groups into one coordinate chart. As we can see from fig.4. In this asymmetric replication dynamic evolutionary game, it is easy to see that there are two evolutionary stable strategies in this game, namely $(1, 0)$ and $(0, 1)$. That is to say, generally speaking, a multinational company tends to choose initiative R&D, a domestic enterprise tends to choose introduction, or it reaches the opposite balance. And it also shows that, In a

patent R&D game of a multinational company and a domestic enterprise, It is impossible to achieve a balanced if both sides rely on introduction or both take initiative R&D. The former will make a particular market to become atrophy and depression; the latter will result in a waste of resources of the whole society due to Repeat innovation.

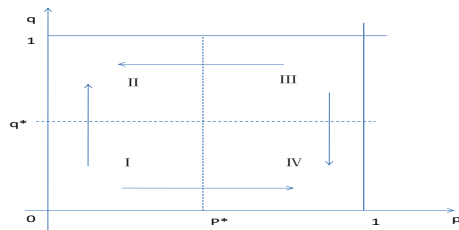


Figure 5 Relationship and stability of replication dynamic of two groups

IV. EVOLUTION ANALYSIS OF THE MODEL

A. The initial state influence the evolution process

In the game of choosing patent strategy, When the initial state falls on region II, with the learning and imitation of a company, The game will eventually converge to the evolutionary stable strategy $p = 0$ and $q = 1$. When the initial state is region IV, the situation is the opposite to the situation of falling in region II. That is, The game will converge to the evolutionary stable strategy $p = 1$ and $q = 0$, That is to say, in a patent game, a multinational company tends to choose initiative R&D, a domestic enterprise tends to choose introduction. In other words, In the initial condition, for a domestic enterprise, If the inventory of technology assets is fewer, the costs of R&D higher, benefits of innovative lower; At the same time, if the multinational company has stronger technical power, Lower R&D costs and higher innovation benefits, then under a technology monopoly threat of the multinational company, the temptation of comparative advantage of later technical development and lacking of sufficient support from the government. The domestic enterprise weighs the costs and risks of introduction and independent R&D, patented innovation activities can easily fall into "comparative advantage trap". So far we have explained the internal mechanism why domestic enterprises tend to lack independent R&D compared to TNCs on the whole.

When the initial state falls on region I or III, eventually, the steady state may converge to $(0,1)$ or $(1,0)$, It depends on how fast game players can learn and adjust themselves. Now we take the initial state falling on region I, for example, if the speed of domestic enterprises B converges to $q = 1$ is higher than TNCs A convergence to $p = 1$, That is to say, for domestic enterprises group, if its growth rate of the proportion of taking the initiative R & D is greater than multinational corporation group's, the game will enter region II and the final stable strategy will be $(0, 1)$. Otherwise, the game will enter region IV and the final stable strategy will be $(1, 0)$. In summary, Evolutionary trend of enterprise patent behavior will change with the initial state of two game players and

converge to different equilibrium point, and it will also form into different evolutionary stable states in different ways because of different adjust the learning ability of both sides.

B. Parameters influence evolution process

Since we assume that enterprises are "myopia", which means they have limited rationality, so enterprises are allowed to make mistakes in our model. If the equilibrium has entered region II, But some enterprises of multinational enterprises group make a mistake, Make equilibrium enter regions III, So this time it entered a non-equilibrium state, For both sides of game players, the number of companies which choose the strategies of introducing patent become less, But eventually it will converge to an equilibrium, It depends on which region it will enter ultimately, region II or IV.

Now we come back to the real issues. According to the phase diagram shown in Figure 5, if $p = (k_2v_2 - d_2 + k_2c) / (k_2c + r_2u_2 - c)$ becomes larger, region II will become larger, When companies fall on region III because of making mistakes, eventually, the possibility for equilibrium tends to II is greater than IV. That is to say, the Possibility of tending to $(0,1)$ becomes larger for equilibrium. Namely the possibility of independent research and development of domestic enterprises become larger. As "the player", Bounded rationality game players may not be able to achieve the best results through replication dynamic learning and adjustment of strategy. But the government, who is the game's "outsider", plays the relatively rational role. Considering these factors that affect p , government can take some effective measures to improve the patents innovation initiative of domestic enterprises.

(1) Increases the success probability of R&D k_2 .

For the domestic enterprises which lack of both technical and financial resources, even if they have a strong independent research motivation, it is a big problem whether they can raise sufficient capital for the project. In order to attract domestic and foreign experts and outstanding creative talents into domestic enterprises to do R & D activities in independent innovation, government can help domestic enterprises to establish an expert workstation, guide enterprises, universities and research institutes to strengthen technical exchanges and cooperation, provide basic services of technology R & D, such as open laboratory and technology research center to domestic enterprise. Government can also encourage and support the establishment of patent alliance to promote technology exchange and knowledge sharing among enterprises and among enterprises, universities and research institutes.

(2) Increase the extra revenue of successful R&D v_2

Government procurement should give priority to domestic brands, especially to some advanced technology products which have huge market potential, represent the direction of technology development and are identified by the authorities that need major support, they should be first purchased by government departments. Government can make more use of the role of market mechanisms, Accelerate the transformation and application, Strengthen

the investment in key areas, Promote R&D and promotion of key technologies in key industries.

(3) Reduce the costs of R&D d_2

For domestic enterprises, individual income is much less than social benefits when they create a new patent achievements, and the company which is the first to make a new achievement finds it difficult to recover the spillover benefits of that innovation. In order to stabilize research team and ensure the smooth of patent R&D, the government should make more efforts to support innovation of the core patents and give an active financial support to R&D institutions and research centers of these companies. At the same time, Government departments can provide subsidies, cut taxes by formulating policies to reduce the costs of R&D.

(4) Raise patent fee c

The cost of imitation and plagiarism will increase when the protection of intellectual property becomes more restrictive. The cost of imitation and plagiarism will increased if government departments make more efforts in protecting intellectual property. Government can curb patent infringement, regulate the patent market and increase the cost of infringement, thus supervise enterprises to pay patent fees for plagiarism instead of zero cost in the form of formulating policy to protect intellectual property .so that the wishes of enterprise to make a patent innovation will be greatly enhanced.

V. COUNTERMEASURES AND SUGGESTIONS

A. Break the "comparative advantage trap"

It is easy for the patent innovative activities of domestic enterprises to fall into "comparative advantage trap" by weighing the gain and loss and risk trade-offs of different patent strategies. They may have an excessive dependence on the introduction of patent, pick up the pace of the developed countries, and can't improve the capacity of independent innovation in long-term. In the patented innovations evolutionary game inside the enterprise group, On the one hand, Game equilibrium is probably that domestic enterprises have insufficient independent innovation because of disparity in strength; On the other hand, Domestic enterprises may also do not choose the optimal behavior because of limited rationality. When these happens, government, who is Relatively rational, can promote patent innovation of domestic enterprises through financial and industrial policy interventions, and make full use of guiding and coordinating role of government in innovation system and activities of the entire country, thus break the "comparative advantage trap", led results of the patent game into the pattern which is beneficial to us.

B. Independent R&D and technology introduction both cannot be neglected

There may be an unnecessary waste of resources if domestic enterprises focus only on Independent R&D rather than on the absorption of the world's advanced technological achievements, and they may lag behind the level of development of the world science and technology for a long-term. Meanwhile, domestic enterprises must

focus on R&D capabilities and digest ability in the process of introducing foreign advanced technology. Only in this way, can we avoid the passive situation of "introduction - imitation - re-introduction - re imitation", and make full use of the world's scientific and technological resources to accelerate our own pace of development. It has important implications for sustainable economic growth, after all, the real core technology and high-technology is not easy to be introduced.

5.3. Formulate policy according to the actual situations.

The improvement of intellectual property protection should be gradually implemented based on technical level and development stage of our country. For our country which is a technology latecomer, the relationship between intellectual property protection and technological progress is not simple linear, it is related to the relative technical level and imitation ability of the country. When a country has a relatively high technology level, the regime which strengthen IPR protection tends to encourage domestic independent innovation; When a country has a relatively low technology level, the IPR protection regime which encourage them to imitate other technologically advanced countries may benefit the technological progress instead. Government should determine adequate IPR protection based on the relative technology level and imitation ability when in the dilemma between encouraging independent innovation and imitation of foreign technology.

C. Formulate policy according to local conditions.

The technology level gap between eastern and middle region and foreign countries is relatively small, technology between domestic and foreign are strong alternative. These areas achieve their technological upgrading and economic developments mainly rely on independent R&D in the market competition. The technology level gap between western region and foreign countries is relatively large, technology between domestic and foreign are strong complementary. These areas are also lack of independent innovation infrastructure and a supporting environment, so technology introduction is benefit for technology upgrading in western region. Strengthening intellectual property protection blindly may hinder the development of local economic and technological progress. Therefore, government should formulate policy according to local conditions.

ACKNOWLEDGMENT

This paper was funded by: National Science and Technology Program "standard patent licensing and regulatory mechanism of monopolistic behavior" (NO.2010GXS5D211), National Social Sciences Fund Program (NO. 15BJL035), Zhejiang Science and Technology Program (NO. 2014C25028), National Natural Science Fund Program (NO. 71103168, NO.71210107020), The Ministry of education of Humanities and Social Sciences Program (NO. 12YJC790078, NO. 13YJC630056), The Humanity

and Social Science Research Institute of Key Universities in Zhejiang Province.”Standardization and Intellectual Property Management Focus”

REFERENCES

- [1] MacDougall G.D.A. “The Benefits and Costs of Private Investment from A broad: A Theoretical Approach”. *Economic Record* 1960, 36(73): 13-35.
- [2] Caves RE. “Multinational Firms Competition and Productivity y in Host country y Markets”. *Economica*, 1974, 41(162):176-193.
- [3] Aitken B, Harrison A.. “Do Domestic Firms Benefit from Direct Foreign Investment? Evidence From Venezuela”. *The American Economic Review* 1999, 89(3):605-618.
- [4] Gorg H, Greenaway D. “Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment?”. *The World Bank Research Observer* 2004, 19(2):171-197.
- [5] CRESPO N, FONTOURA M P. “Determinant Factors Of FDI Spillovers What Do We Really Know?”. *World Development*, 2007, 35(3):410-425.
- [6] Todo Y, Miyamoto K. “Knowledge Diffusion from Multinational Enterprises the Role of Domestic and Foreign Knowledge Enhancing Activities”. *Paris: OECD Development Centre*.2002.
- [7] Todo Y., Miyamoto K. “Knowledge Spillovers from Foreign Direct Investment and the Role of R&D Activities Evidence from Indonesia J”. *Economic Development and Cultural Change* 2006.55(1):173-200.
- [8] Todo Y. “Knowledge Spillovers from Foreign Direct Investment in R&D: Evidence from Japanese Firm level Data”. *Journal of Asian Economics* 2006, 17(6):996-1013.
- [9] A. Marin, M. Bell. “Technology Spillovers from Foreign Direct Investment FDI the Active Role of MNC Subsidiaries in Argentina in the 1990s”.*The Journal of Development Studies* 2006, 42(4):678-697.
- [10] Liu Yun, Xia Min, Wu Xiaoming. “Measuring research on the patent activity and its impact of China's largest 500 foreign-invested enterprises in China”. *Forecast*, 2003,22 (6): 19-23.
- [11] Xian Guoming, Bo Wenguang. “Influence of FDI technology innovative on domestic enterprises: analysis based on industry level”. *Nankai Economic Research*, 2005 (6): 16-23.
- [12] Li Ping, Liu Jian. “FDI, foreign patent applications and technical progress in all areas of China: empirical Analysis from International Technology Diffusion perspective”. *International trade issues* 2006 (7): 99-104.
- [13] Zhang Chuanjie, Qi Su, Zhu Xuezhong. “Research on the impact of TNCs technology spillover on domestic enterprises’ patent output: Based on analysis of industry panel data model”. *Journal of Intelligence*, 2010, 29 (3): 1-5.