

## Game Analysis on Generic Technology Diffusion Process in Industry Cluster

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### Abstract

Generic technology in industry cluster refers to the widely used technology in pre-competitive stage in industry cluster and it plays a decisive role in the survival, advancement and development of the industry cluster. It possesses such characteristics as basic, advanced, sharing, risk, positive externality, and it is microcosmic and applicable. And the Research and development and diffusion of generic technology in industry cluster exert positive influence on the development of the enterprises in industry cluster, the whole cluster as well as regional economy. Therefore, this paper attempts to make a dynamic game analysis on the behaviors of companies during the diffusion of generic technology in industry cluster under the mode of market supply, and gives advice on the promotion of the research and development and diffusion of generic technology in cluster.

**Key words:** Diffusion process; Game analysis; Generic technology; Industry cluster

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### INTRODUCTION

Generic technology, used in various kinds of industries and regions, will not only promote the economic and social development, but also exert positive influence on the advancement and development of a country's industry technology. China has paid great emphasis on generic technology. On October 18<sup>th</sup> 2010, the State Council of china had published a document called "Decision on Accelerating the Development and Cultivation of New Industries", indicating that our country would concentrate on developing some significant generic technology, combined with the implements of the Country Scientific and Technological Program, Knowledge Innovation Projects and Natural Science Foundation. The research and development and diffusion of generic technology advance the development of industry cluster. Industry cluster in turn further stimulates the development and innovation of generic technology. The research and development and diffusion of generic technology in industry cluster impulse the technological innovation and the upgrade of industry structure as well as the competitiveness of the area. Meanwhile, industry cluster provides an important platform for the diffusion of generic technology.

At present, the research and development of generic technology in industry cluster focus on the innovation, supply, research and development of generic technology as well as the selection of key generic technologies. LI Jizhen (2006) said that generic technology had four characteristics, that were, basic, openness, externality and relevance. YU Xijun (2006) maintained that regional scientific and technological innovation service center, research and development center of key companies and research and development institute of prestigious universities constituted innovative carrier of generic technology. ZENG Fanying(2009)had studied on the supply mode of research and development of generic technology in industry cluster, and found that there were three types, including government supply mode, market supply mode and organizational supply mode. Market

mode referred to the situation that those companies with independent property in the industry cluster made full use of various kinds of resource to make research and to gain profits by selling its research findings to other companies in the industry cluster. WEI Zhuhong (2009) studied the cooperative way of innovation of generic technology in industry cluster in his master degree paper. ZHOU Qiao (2010) deemed that the diffusion of generic technology in industry cluster was the popularization of the innovative generic technology through the proper channel.

The studies above demonstrate that scholars have recognized the importance of the diffusion of generic technology in industry cluster. Their research findings have laid a solid foundation in research and development and enriched theories on generic technology in industry cluster. However, the diffusion of generic technology in industry cluster entails further research. With the development and improvement of the technology market, providing generic technology the industry cluster needed through market becomes the direction of future development. Therefore, this paper attempts to make a dynamic game analysis on the behaviors of companies during the diffusion of generic technology in industry cluster under the mode of market supply, which contributes to the effective spread and absorb of the generic technology for companies in industry cluster, putting forward of appropriate policies to enhance the development of generic technology in industry cluster, and the overall economic development of the industry and the whole region.

## 1. DYNAMIC ANALYSIS ON THE DIFFUSION OF GENERIC TECHNOLOGY IN INDUSTRY CLUSTER

Generic technology in industry cluster refers to the widely used technology in pre-competitive stage in industry cluster and it plays a decisive role in the survival, advancement and development of the industry cluster. Generic technology in industry has characteristics like general generic technology (basic, advanced, sharing, risk, positive externality). In addition, it possesses two particular characteristics. On the one hand, it is microcosmic, which means this kind of generic technology is not at the national level, but at a particular level of regional industry cluster. On the other hand, it is applicable, mainly addressing the generic applied technology influencing and leading economic and technological progress of the industry cluster.

### 1.1 Game Model Assumptions

Assumption 1: There is a strong company  $B$  and a weak company  $S$ . The strong company has developed a generic technology with the value  $V$  ( $V$  represents  $B$ 's investment in this technology), denoting  $\pi(\pi > V > 0)$  as the profit after its application. Furthermore,  $M$  and  $N$  are

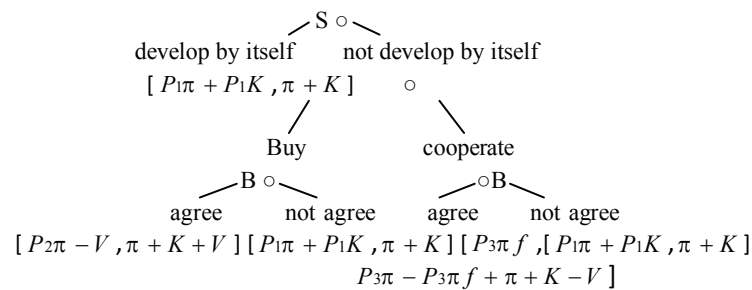
the earnings of  $B$  and  $S$ . Generic technology can provide a wide range of potential application opportunities and is regarded as an important basic technology applying in the future specific products. And they will exert imperative impact on technological level and competitiveness of industries, thus enhancing the industrial competitiveness of a region or a country. So the government will award the successful development of generic technology. Here we assume  $K(\pi > K > 0)$  as the government's award for the successful development of a generic technology.

Assumption 2: This game is a dynamic game with company  $S$  taking action first. There are three strategies: The first strategy is company  $S$  developing the generic technology by itself with a large amount of research and development investment. The second strategy is company  $S$  buying the generic technology from company  $B$ . The third strategy is company  $S$  signing a cooperative agreement with company  $B$  to take part in the development and application of the generic technology.

Assumption 3: Let  $P_1$  represents the probability of success of company  $S$  when developing generic technology by itself. Let  $P_2$  represents the probability of success of company  $S$  when buying generic technology from company  $B$  and applying it. Let  $P_3$  ( $1 > P_1 > P_2 > P_3 > 0$ ) represents the probability of success of company  $S$  when signing a cooperative agreement with company  $B$  to take part in the development and apply the generic technology, and in this situation, company  $S$  doesn't need to pay the generic technology, but need to share profits after its successful application of the technology with company  $B$ , denoting  $f$  ( $0 < f < 1$ ) as the sharing ratio of company  $S$  and  $1-f$  as the sharing ratio of company  $B$ .

### 1.2 Game Model Construction

First, when company  $S$  choose strategy one (developing the generic technology by itself with a large amount of research and development investment), its earning  $N$  is  $P_1\pi + P_1K$ , and company  $B$ 's earning  $M$  is  $\pi + K$ . Second, when company  $S$  choose strategy two (buying the generic technology from company  $B$ ), if company  $B$  agree to sell the generic technology to company  $S$ , then company  $S$ 's earning  $N$  is  $P_2\pi F$ , company  $B$ 's earning  $M$  is  $P_2\pi - P_2\pi f + \pi + K - V$ ; if company  $B$  doesn't agree to sell the generic technology to company  $S$ , then company  $S$ 's earning  $N$  is  $P_1\pi + P_1K$ , company  $B$ 's earning  $M$  is  $\pi + K$ . Third, when company  $S$  choose strategy three (signing a cooperative agreement with company  $B$  to take part in the development and apply the generic technology), if company  $B$  agree to cooperate with company  $S$ , then company  $S$ 's earning  $N$  is  $P_3\pi f$ , company  $B$ 's earning  $M$  is  $P_3\pi - P_3\pi f + \pi + K - V$ ; if company  $B$  doesn't agree to cooperate with company  $S$ , then company  $S$ 's earning  $N$  is  $P_1\pi + P_1K$ , company  $B$ 's earning  $M$  is  $\pi + K$ . In conclusion, this dynamic game can be expressed by the game tree as follows:



**Figure 1**  
**Game Tree of Diffusion of Generic Technology in Industry Cluster**

According to Nash equilibrium:

$$\max [ P_2\pi - V - (P_1\pi + P_1K) ][ \pi + K + V - (\pi + K) ]$$

$$\max [ P_3\pi f - (P_1\pi + P_1K) ][ P_3\pi - P_3\pi f + \pi + K - V - (\pi + K) ]$$

Then solve the two terms above respectively, we get:

$$V = [(P_2 - P_1)\pi - P_1K] / 2$$

$$f = [(P_3 + P_1)\pi + P_1K - V] / 2P_3\pi$$

### 1.3 Game Model Analysis

First, compare strategy one and strategy three. Apparently, company *S* developing generic technology by itself is not a rational choice in any case because research and development of generic technology demands a large amount of capital, human resources and so on, and company *S* will assume more risks than company *B* while developing technology alone due to its weak strength of all aspects. All this make  $P_1$  very small. What's more, company *S*'s investment for successful research and development is much higher than government award. Therefore, generally speaking, as a rational company, company *S* will not choose to develop a generic technology by itself.

Second, compare strategy two and strategy three. We can come to the conclusion that (purchase, agreement) is the optimal balance when  $[(P_1K + V)/\pi] < (2P_2 - P_3 - P_1)$  and (cooperation, agreement) is the optimal balance when  $[(P_1K + V)/\pi] > (2P_2 - P_3 - P_1)$ .

For (purchase, agreement), company *S* will choose to buy the generic technology when its learning ability ( $P_2$  in this paper) is relatively strong and company *B*'s selling price of generic technology ( $V$  in this paper) is relatively cheap. Generic technology in industry cluster can always be widely used in the cluster because it is microcosmic and basic, so small companies like company *S* in the cluster usually intend to buy the technology in order to promote its own development; large companies in the cluster also tend to buy the technology, for it is conducive

to its research and development of more advanced technology and to some extent avoiding repeated development, which reduce the costs for developing more advanced technology. Therefore, as long as the selling price of the generic technology ( $V$ ) is proper, it is wise for company *B* to sell and diffuse the technology to gain the profits while it is wise for company *S* to buy the technology.

For (cooperation, agreement), industry cluster is considered to be a good platform for research and development and diffusion of generic technology, and developing the generic technology by cooperation is indeed a process of diffusing it. Developing the generic technology by cooperation can achieve economies of scale in research and development and diffusion, effectively disperse risks of research and development process, avoid repeated developing through different companies assuming different projects and make the negative externality internalized through cooperative development. Company *S* intends to cooperate with company *B* to develop the generic technology and apply it when its learning ability ( $P_2$  in this paper) is relatively weak and company *B*'s selling price of generic technology ( $V$  in this paper) is relatively expensive. And the research and development process can also be seen as the learning process of company *S*, which helps company *S* applying the technology more efficiently, thus gaining profits. Company *B* can obtain relatively big share after successful application of generic technology when  $f$  is relatively low ( $1 - f$  is relatively high), meanwhile, it can also receive government award  $K$  after successful development and diffuse and sell the generic technology to get other profits. Therefore, in this case, it is wise for company *B* to agree to cooperate with company *S* in the research and development of the technology, while it is wise for company *S* to cooperate with company *B* to develop the technology.

### 3. RECOMMENDATIONS TO PROMOTE THE RESEARCH AND DEVELOPMENT AND DIFFUSION OF GENERIC TECHNOLOGY IN INDUSTRY CLUSTER

#### 3.1 The Government Should Improve Relevant Laws and Regulations

There exist double failures of markets and organizations in the diffusion of the generic technology in industry cluster because of a series of characteristics of generic technology in cluster, which require the government to establish a series of laws and regulations, such as ameliorating related intellectual property rights, patent laws, contract laws, technology transfer laws and so on, to standardize and protect the innovation and diffusion process. At the same time, government should create a fair environment based on cooperation for competition and research and development and diffusion of generic technology in industry cluster.

#### 3.2 The Government Should Provide Appropriate Financial Supports

The government should offer companies in industry cluster developing and diffusing generic technology some referential policies like research and development funding and award, tax relief because of the high risk and investment of generic technology. Moreover, it should promote the cooperation between the financial institutions and companies in cluster, ensuring the efficient exchange of information between them, so that the financial institutions can choose to invest proper R&D projects of generic technology and are willing to bear risks with the companies who develop the generic technology.

#### 3.3 Large Companies in Cluster Should Give Full Play to its Advantages

Large companies in the cluster can make full use of its advantages, such as rich human resources, lots of funds and etc. to sign contract with small companies to cooperate with them in developing generic technology. In this way, first, they can obtain the government award after successful development and a part of profits from the small companies after the successful application of the generic technology. Second, they can elevate their figure through selling the generic technology to other companies both in the cluster and out of the cluster to get extra profits, thus promoting the future development of the company. Third, cooperating with other companies in developing the generic technology through different

companies assuming different projects can avoid repeated investment and research and development, save time, and finally improve the efficiency of research and development.

#### 3.4 Small Companies in Cluster Should Locate Themselves Rationally and Enhance Capabilities in All Aspects

On the one hand, small companies should choose to buy or cooperate with large companies based on their own levels according to their characteristics and technological capacities, so as to give full play to their own advantages. On the other hand, learn continuously, cultivate creative ability and fully aware of the importance of innovation and diffusion of generic technology to a company. Meanwhile, enhance learning and research and development abilities of the employees through education, training and other ways.

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