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Study on the Relationship between Enterprise Cooperative R and D and Government Fund Positioning Based on the Industrial Generic Technology R and D

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Abstract: Industrial generic technology lies between basic research and market-oriented product development, belongs to the pre-competitive technology and is the first step of knowledge innovation towards the market. The enterprise cooperative R and D is considered as an effective organization form in favor of generic technology development by countries, however, for the industrial generic technology R and D is closer to the market application, key enterprises in industry need to conduct the generic technology cooperation at the top of industrial chain, but they have to develop face to face market competition in final product market at the bottom of industrial chain, therefore, the enterprise cooperative R and D is affected by attractor and repeller and the effective intervention of government is very important to enterprise cooperative R and D. By building model, this study studies the characteristics of attractor and repeller which affect enterprise cooperative R and D, in order to encourage enterprise cooperative R and D and improve the government fund efficiency, the government should take flexible fund strategy based on the industrial generic technology, the whole industry competition situation and strength characteristics of key enterprises.

Key words: Generic technology, cooperative R and D, government fund

INTRODUCTION

Industrial generic technology is the technology that is widely used in several industrial fields and produces a profound effect on industry and belongs to the pre-competitive technology (Li, 2005). For China's manufacturing industry, the industrial generic technology includes multi-scale modeling and simulation in process of manufacturing, micro-manufacturing technology from submicron to nanometer and green manufacturing technology (including 3R technology). And governments of developed countries attach great importance to the industrial generic technology R and D, the "mixed trade and competition law" in United States makes clear the properties of American Advanced Technology Program (ATP) supporting the industrial generic technology R and D and the law regulates that the goal of ATP program is to help enterprises in America to create and apply the generic technology and the corresponding research results, make the big, new scientific discoveries and technologies commercialized quickly and improve manufacturing technology. In addition, the ATP program speeds up all kinds of pre-competitive generic technology development through the ways of subsidy and cooperative agreement in order to improve the competitive position of enterprises in America.

Industrial generic technology lies between basic research and market-oriented product development, plays an important role in technological innovation chain and is the source and security of industry core competence (Liu, 2013). For the current supply system of industrial generic technology in China, Li (2007), academician of China Engineering Academy, holds that the intermediate link (namely industrial generic technology) of the innovation system appears vacancy, projects of National Natural Science Foundation of China and "973" plan are mainly for basic research investment and the venture capital and enterprise investment are mainly aimed at product development, therefore, the industrial generic technology research and technology transfer become the weakest link of technology innovation chain in China. The industrial generic technology lies in the intermediate zone of government, non-profit institutions and for-profit institutions represented by enterprises. For the industrial generic technology requires lots of R and D costs and has the characteristics of uncertainty and externality which is

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prone to form the situation of no supply for profit and non-profit organizations that is the "failure" of system supply. And it undoubtedly has important practical significance so as to strengthen the innovation management of industrial generic technology R and D, enhance the weak links of industry innovation chain, break through the technology bottleneck of industry development, improve the industrial competitiveness, achieve industrial transformation and upgrading for China and build an innovative country.

LITERATURE REVIEW

Tassey (1991, 1992) has carried out the generic technology research earlier, but the theoretical research on generic technology relatively lags to the demands of science and technology policy and industrial economy development in China. Ma (2005) holds that the research on generic technology mainly comes from the summary of policy practice instead of the theoretical analysis in China. Scholars in China have studied the role of government in industrial generic technology development from different aspects. Wu and Li (2003) consider that the original intention of system reform for scientific research institution based on the level of national industry department is to thoroughly solve the disseverance of technology and economy which hinder the economic development and scientific and technological progress in China for a long time, but the transformation of industry scientific research institution will bring a special kind of technology-the phenomenon of no supply of industrial generic technology. Tang *et al*. (2005) has proposed to establish major national generic and public welfare technology extension and application plan. Li (2005) has discussed the role of government in solving the problem of market and organization failure in process of generic technology supply. And the domestic academia generally holds that the industrial generic technology R and D has very important significance in constructing innovation-oriented country. However, the lack of innovation subject, insufficiency of supply ability and the imperfect diffusion mechanism of industrial generic technology as well as the unclear government function positioning are still key problems of restricting industrial technology innovation in China (Sun and Li, 2006).

At present, more and more enterprises have started to develop the industrial generic technology by adopting the mode of cooperative development. The characteristics of cooperative R and D include: Avoiding duplicated R and D in order to save costs, sharing resources and high collaboration of technology to break through the key technology and the scale input of R and D funds in order to break through the bottleneck (Vonortas, 1997; Tao and Wu, 1997; Kline, 2000). Nowadays, cooperative R and D has become an important pattern of enterprises technology innovation and product innovation management (Yao and Wang, 2013). For example, three large automobile firms of Japan Honda, American General and German BMW jointly research the next generation hydrogen fuel cell technology to reduce the technology development costs and simultaneously promote the standardization of fuel nozzle and hydrogen supply system. And the five large competing semiconductor manufacturers of Japan Toshiba, Hitachi, Panasonic, NEC and Renesas build the R and D alliance of next generation processor through integrating their own chip sectors in order to reduce their R and D costs. Semiconductor manufacturers of Infineon Technology and Nanya Technology conduct cooperation in Dynamic Random Access Memory (DRAM) technology in order to strengthen the competitive advantage of both parties in the DRAM market and share high R and D costs.

For industrial generic technology research lies in the pre-competitive stage and spans two stages of application research and pre-competitive experimental development and the technical advantages often concentrate in a few key enterprises in industry which need the "platform" of generic technology for subsequent commercial development and eventually form proprietary products of enterprises. The enterprises need the cooperative R and D of industrial generic technology and also have to conduct face to face competition in the final product market and the characteristics of attraction and exclusion directly affect the enterprise cooperative R and D, the relevant coordination and support policies from government are critical in balancing the characteristics of attractor and repeller. Therefore, it is necessary to analyze key characteristics of influencing attractor and repeller of cooperative R and D between enterprises and the relevant government fund positioning, in order to effectively play the government fund efficiency, accelerate China's industrial generic technology development and improve the overall competitive advantage of industry in the world.

ANALYSIS MODEL

Assuming that it exists duopoly enterprises A and B in industry which plan to develop the industrial generic technology, conduct subsequent commercial development on the basis of generic technology, finally form a commercial product and share related revenues according to the respective market. Assume the overall market revenue to be constant and the market annual

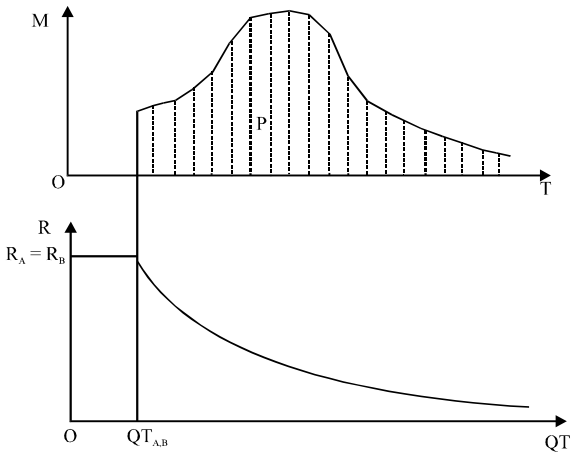

Fig. 1: Time function for product into market (QT) and the market revenue function (M)

revenue alters with the life cycle curve of product. In general, setting the market annual revenue function of new product is M which has been shown in Fig. 1 (Although, the cycle curve of product in each field is different, it does not affect the results of the study). When the new product is put into market firstly, the life cycle of product begins and keeps until the product is completely replaced.

The R and D ability of enterprise determines the R and D time of technology and thus directly affects the time of subsequent commercial product into the market. Setting the R and D ability of enterprise is R (including technical experts, experiment equipments and other factors), enterprise with higher R and D ability firstly launches the new product, therefore, the time of monopolizing the market benefits for the enterprise will be longer. Setting the time for product into market is QT which is the function of enterprise R and D ability R. As shown in Fig. 1, the role of QT in launching new products shows a marginal decrease with the increase of R and D ability (Lihui, 2003).

When $T = QT_{A,B}$, the two enterprises simultaneously develop generic technology and successfully launch subsequent commercial product, the incomes for enterprise A and B are as follows:

$$P_i = S_i \bullet \int_{T=QT_{A,B}}^{T=TF} MdT - C_i \ (i = A, B) \quad (1)$$

In which, S_A and S_B mean the market share of enterprise A and B which is determined by the marketing ability made up of enterprise marketing channel and brand. TF means the end moment of technology life cycle. C_A and C_B mean the R and D costs for enterprise A and B. For the same R and D project, because of the thick technology precipitation, strong expert resources, agile thought while solving problem and little detours for enterprise with higher R and D ability, its R and D cost is lower than the enterprise with weaker R and D ability, therefore. When:

$$R_i > R_j, C_i < C_j \ (i, j = A, B. \ i \neq j) \quad (2)$$

For enterprise develops the industrial generic technology, besides the R and D ability of enterprise itself, it still needs the corresponding R and D funds, setting enterprise funds used in generic technology development is Z, the necessary condition for enterprise to conduct independent development is as follows:

$$Z_i > C_i \ (i = A, B) \quad (3)$$

$$P_i > C_i \ (i = A, B) \quad (4)$$

For industrial generic technology, the strategy space of enterprise includes nonfeasance, independent and cooperative R and D. For cooperative R and D, partners essentially have grasped the technology at the end of R and D project and they usually put into same R and D funds, otherwise, the cooperative R and D negotiations in unequal situation will be more difficult.

The cooperative R and D willingness between enterprises in industrial generic technology is mainly affected by attractor (the R and D investment, R and D risk and complementary of technical resources) and repeller (the differences in the marketing channel and brand and the superior characteristics of forerunner). To simplify the analysis model, the risk and externality of industrial generic technology R and D are not considered in this study.

The feasibility analysis of enterprise cooperative R and D when key enterprises have similar R and D ability and independent R and D condition: As shown in Fig. 1, $R_A = R_B$ means that enterprise A and B have developed a new technology simultaneously when $T = QT_{A,B}$.

When enterprise A and B conduct independent R and D, their incomes are as follows:

$$P_i^D = S_i \times P - C_i \ (i = A, B) \quad (5)$$

When enterprise A and B conduct cooperative R and D, their incomes are as follows:

$$P_i^G = S_i \times P, \ C_i/2 \ (i = A, B) \quad (6)$$

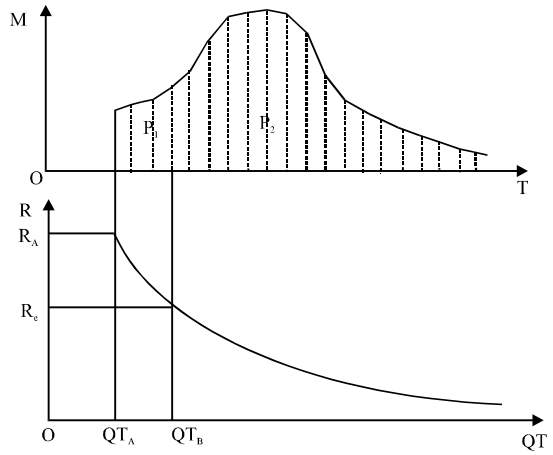

Fig. 2: Time of launching new products and corresponding market revenue for enterprise A and B when $R_A>R_B$

For $P_1^G>P_1^D$, whether S_A and S_B are equal or not, both sides have incentives to participate in cooperative R and D. In this situation, the role of government is not to fund the enterprise or cooperative R and D organization, but actively coordinate enterprises to conduct cooperative R and D, in order to save R and D costs and eventually improve the industry competitive advantage.

The feasibility analysis of enterprise cooperative R and D when key enterprises have unequal R and D ability but independent R and D condition: As shown in Fig. 2, assuming $R_A>R_B$, enterprise A develops the new technology when $T = QT_A$ and its R and D ability is better than enterprise B which could develop new technology when $T = QT_B$.

In such cases, when enterprise A and B conduct R and D activities individually, their incomes are as follows:

$$P_A^D = P_1+S_A\times P_2-C_A \quad (7)$$

$$P_B^D = S_B\times P_2-C_B \quad (8)$$

In which, P_1 means market gains in the stage of $T = QT_A$ and QT_B, P_2 means market gains after $T = QT_B$ and P_2 is divided by enterprise A and B according to their market share. For P_1, it is individually obtained by enterprise A with characteristics of monopoly which derived from the advantages of forerunner, because the market forerunner could build resource advantage in the market and could get more tangible and intangible assets than others, including technology knowledge, brands and trademarks which manifests as geographic space, technology space and perceptual space of customers (Liberman and Montgomery, 1988).

In this case, When enterprise A and B conduct cooperative R and D, their income are as follows:

$$P_A^G = S_A\times P-C_A/2 \quad (9)$$

$$P_B^G = S_B\times P-C_A/2 \quad (10)$$

If the cooperative R and D is the dominant strategy of both sides, it requires that:

$$P_A^G-P_A^D = C_A/2-S_B\times P_1>0 \quad (11)$$

$$P_B^G-P_B^D = S_B\times P_1+C_B-C_A/2>0 \quad (12)$$

To make enterprise A have incentive for cooperative R and D, it demands $C_A/2-S_B\times P_1>0$, when C_A keeps invariant, the greater the SB and the smaller the P1 which means that only when the R and D abilities of enterprise B and A are extremely close, enterprise A could be motivated to conduct cooperative R and D with enterprise B. Instead, when both S_B and P_1 are smaller, enterprise A has incentive for cooperative R and D which becomes weaker with the increase of marketing ability of enterprise B. For enterprise B, $C_B>C_A$ while $R_A>R_B$ and conditions in the equality Eq. 12 are met, therefore, enterprise B always has enthusiasm of cooperative R and D with enterprise A.

In this case, the government could take the following strategies (1) When enterprises have big gap between marketing ability, but similar R and D ability, the government should actively coordinate enterprises to conduct cooperative R and D and (2) When enterprises have big gap between marketing and R and D ability, the government could only fund the cooperative R and D which is possible while $M>S_B\times P_1-C_A/2$.

The feasibility analysis of enterprise cooperative R and D when one party is unable to conduct independent R and D while the other side has the independent R and D ability: Assuming $P_B<C_B$ and $R_B<R_A$, when enterprise B conducts independent R and D, the market returns are less than R and D costs and its R and D ability is weaker than enterprise A.

In this case, if the enterprise A conducts independent R and D, it will monopolize all market gains:

$$P_A^D = P-C_A \quad (13)$$

To make enterprises A has incentive for cooperative R and D, it requires:

$$P_AG>P_A^D \quad (14)$$

That is $C_A/2-(1-S_A)\times P>0$ which means that the industrial generic technology requires large amounts of R and D investment and strong marketing ability for enterprise A, only in this situation, enterprise A has motivation for cooperative R and D with enterprise B, otherwise, enterprise A has no interests in cooperation with enterprise B.

In this situation, it is difficult for government to make two enterprises conduct cooperation only through coordination, it needs to fund the cooperative R and D organization and enterprises could effectively carry out cooperative R and D only when $M>(1-S_A)\times P-C_A/2$.

The feasibility analysis of enterprise cooperative R and D when the R and D cost is extremely high and key enterprises can't afford to rely on their own strength: In this case, $Z_A<C_A$, $Z_B<C_B$ and $Z_A+Z_B<C$ ($C = \min(C_A, C_B)$), both of enterprises have cooperative R and D incentives, but high R and D costs make enterprises not rely on their own strength to cooperate and the government should fund the cooperative R and D organization through project establishment and the amount of fund is as follows:

$$M>\max(C/2-S_A\times P, C/2-S_B\times P) \quad (15)$$

Inductive analysis of four kinds of the model: We can see from the above:

- When key enterprises have similar R and D ability and independent R and D condition, the probability of cooperative R and D for enterprises is great and in this case, the role of government is not to fund enterprises or cooperative R and D organization, but actively coordinate the two enterprises to conduct cooperative R and D in order to save their R and D cost and eventually improve the industry competitive advantage
- When key enterprises have unequal R and D ability but independent R and D condition, the decision-making of enterprise cooperative R and D is mainly affected by the differences of enterprise marketing ability in subsequent product competition and the financial aid policy of government should be planned and implemented according to the characteristics of industry whole competition and specific strength of key enterprises
- When the R and D cost is extremely high and key enterprises can't afford to rely on their own strength, it is not enough for the government only to coordinate, the R and D fund from government becomes the key factor which determines enterprise cooperative R and D

CONCLUSION

The supply system of industrial generic technology in China is not perfect and the existing supply system ignores the practical requirement of enterprise as the main innovation subject to some extent and it lacks of market orientation when the generic technology R and D project is proposed and the R and D fund of government does not fully combine with the characteristics of specific industry and the relevant policy of government to encourage enterprise cooperative R and D. The enterprise cooperative R and D is considered as an effective organization form conducive to generic technology development by countries, China have developed computer technology by four major emergency measures in the 50-60's of 20th century, the main measures are "dispersion after concentration" (competition after cooperation essentially) which has achieved significant results and these historical experiences are worth inheriting and developing (Li, 2007).

The R and D of industrial generic technology, the strategy space of key enterprises in industry includes nonfeasance, independent and cooperative R and D and the strategy adopted by enterprise depends on the characteristics of industrial generic technology (R and D investment, technical externalities and uncertainty) and the competitive strength differences between enterprise itself and its key competitors, meanwhile and it also be affected by the related coordination and fund of government. In order to encourage enterprise cooperative R and D, the strategy space of government includes coordination without fund, low and high amount of fund and the policy positioning of government in industrial generic technology should be based on the characteristics of industrial generic technology, the whole competition situation of industry and the strength characteristics of key enterprises, the higher the R and D ability of enterprise, the more R and D funds, the higher the cooperative R and D incentive and the smaller the government funds and the lower the intervention degree; contrarily, the greater the government funds and the deeper the intervention degree.

REFERENCES

Kline, J.J., 2000. Research joint ventures and the cost paradox. Int. J. Indus. Org., 18: 1049-1065.

Li, G.J., 2007. To strengthen the pre-competitive cooperation and vigorously develop industrial generic technology. Forum Sci. Technol. China, 2: 12-15.

Li, J., 2005. Study on the role of government in industrial generic technology development. Tech. Econ., 9: 12-18.

Liberman, M.B. and D.B. Montgomery, 1988. First-mover advantages. Strategic Manage. J., 9: 41-58.

Lihui, J., 2003. Establishing research joint venture by rivals: A Capability-based analysis. Forecasting, 22: 10-13.

Liu, H., 2013. Research on the innovation of industrial generic technology R and D management: A technology innovation chain perspective. J. Intell., 32: 196-200.

Ma, M.J., 2005. The connotation and evaluation standard of generic technology. New Econ. Weekly, 12: 10-14.

Sun, F. and J. Li, 2006. How to promote the research and generic technology development in China. Forum Sci. Technol. China, 5: 3-7.

Tang, W., F. Zhou and G. Cheng, 2005. Study on the spread and application plan of important commonness and commonweal technology. Sci. Sci. Manage. S. T, 10: 26-32.

Tao, Z. and C. Wu, 1997. On the organization of cooperative research and development: Theory and evidence. Int. J. Indus. Org., 15: 573-596.

Tassey, G., 1991. The functions of technology infrastructure in a competitive economy. Res. Policy, 20: 345-361.

Tassey, G., 1992. Technology Infrastructure and Competitive Position. Kluwer Academic Publishers, Norwell, MA., ISBN-13: 978-0792392323, Pages: 306.

Vonortas, N.S., 1997. Research joint ventures in the US. Res. Policy, 26: 577-595.

Wu, G. and J. Li, 2003. The supply system study of the industrial generic technology. Sci. Technol. Eng., 4: 38-42.

Yao, J. and X. Wang, 2013. Research on product innovation and design management. AISS, 5: 149-155.