Study of Core Rigidity Governing Mechanism of Technological Innovation of Scientific–Technological SMEs Based on Dynamic Gradient Growth

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ABSTRACT

Facing the dynamic and increasingly complex technical and competition environment， how do the Scientific–Technological SMEs continue their technological innovation and keep their proprietary intellectual property rights growing? What abilities the Scientific–Technological SMEs should have to match the technological innovation with the dynamic environment? Regarding the questions above, this article profited from the dynamic theory and the technological innovation ability theory discusses how the Scientific–Technological SMEs continue their innovation from the dynamic innovation ability angle，then safeguard the continual growth of enterprise independent intellectual property rights

Key Words： Dynamic Gradient Growth Pattern；Scientific–Technological SMEs；Technological Innovation；Core Rigidity

1. Introduction

Technological innovation is an important way for Scientific-Technological SMEs to get independent intellectual property rights as well as the power and source of the continual growth of independent intellectual property rights. Meanwhile, technological innovation can guarantee Scientific-Technological SMEs' competitive advantage and against the stagnation. So, scholars and government departments both at home and abroad have paid attention to the technological innovation in Scientific-Technological SMEs, and some valuable investigation of the innovation have been done by them.

The United States, the European Union, Japan, South Korea and other countries have introduced policies and

measures to support Scientific-Technological SMEs to improve technological innovation. For example, the United States has established a special Small Business Administration (SBA) and promulgated the innovation and development of small business technology law, giving support and preferential to the technological innovation of Scientific-Technological SMEs from finance, tax, finance, government procurement, technology, talent, product sales and market development, information services, thus providing a good external support for the technological innovation of Scientific-Technological SMEs. Our government also issued a series of measures, giving support to the technological innovation of Scientific-Technological SMEs from financial, tax, finance and other aspects. In order to improve technological innovation in Scientific-Technological SMEs, the state council approved and set up a technological innovation fund for Scientific-Technological SMEs in 1999, to support the technological innovation of Scientific-Technological SMEs, which has generated remarkable results, and a positive impact on Scientific-Technological SMEs. However, the existence of technological innovation core rigidity seriously constrains the continual innovation of Scientific-Technological SMEs in China.

2 Technological innovation core rigidity analysis of Scientific-Technological SMEs in China.

2.1 Concept of technological innovation core rigidity of Scientific-Technological SMEs.

The concept of the core rigidity was brought out by Barton for the first time in 1992. He thought that long-time accumulation of core competence would create a kind of inertia which made the adaption to changes difficultly for enterprises, that is the core rigidity. That means core rigidity erodes and corrupts enterprises' core competence. There are lots of rigid behaviors for enterprises, but only inert behavior caused by the core ability of enterprises could be called core rigidity behavior.

In recent years, researches of core rigidity at home and abroad can be roughly divided into several directions: the essence of core rigid path dependent, the essence of the generation of core rigidity, knowledge management system, the evaluation index system and evaluation method of the core rigidity, etc. In this paper, we name the factor formed in the process of the technological innovation, reinforcing existing innovation mode, rejecting and obstructing new innovation patterns-- technological innovation core rigidity, based on Barton's "core rigid" concept.

2.2 Causes of technological innovation core rigidity in Scientific-Technological SMEs.

Scientific-Technological SMEs own some advantages in technological innovation, and investigations of the ability of SMEs in promoting technological innovation have been done by scholars. However, at present the fact in the technological innovation of Scientific-Technological SMEs in China is: once an enterprise made successful innovation with successful technique innovation achievements and some independent intellectual property rights, it is difficult for them to get further breakthrough in the process of technological innovation improvement, get constant independent intellectual property rights and the core competitive power, not to mention the continual growth of the enterprises. The story happened in once thrived WanYan DVD Company in Anhui province explains the case well; people can learn a lesson from it about their failure in their technological innovation.

According to the survey on enterprises' patent condition from State Intellectual Property Office Organization; only one patent was applied from an enterprise among 18081 enterprises, accounting for 42% of the total number of enterprises. Among these, in all "a patent application" enterprises, the proportion of SMEs and much smaller enterprises are as high as 57.7% and 35.2% respectively. These phenomena force us to think about the persistent problems of technology innovation ability of Scientific-Technological SMEs in the growth process of independent intellectual property rights. Usually, the process of innovation of Scientific-Technological SMEs is also associated with the formation of the core rigidity. The technological innovation core rigid of Scientific-Technological SMEs is mainly caused by the following aspects, as shown in figure 1.

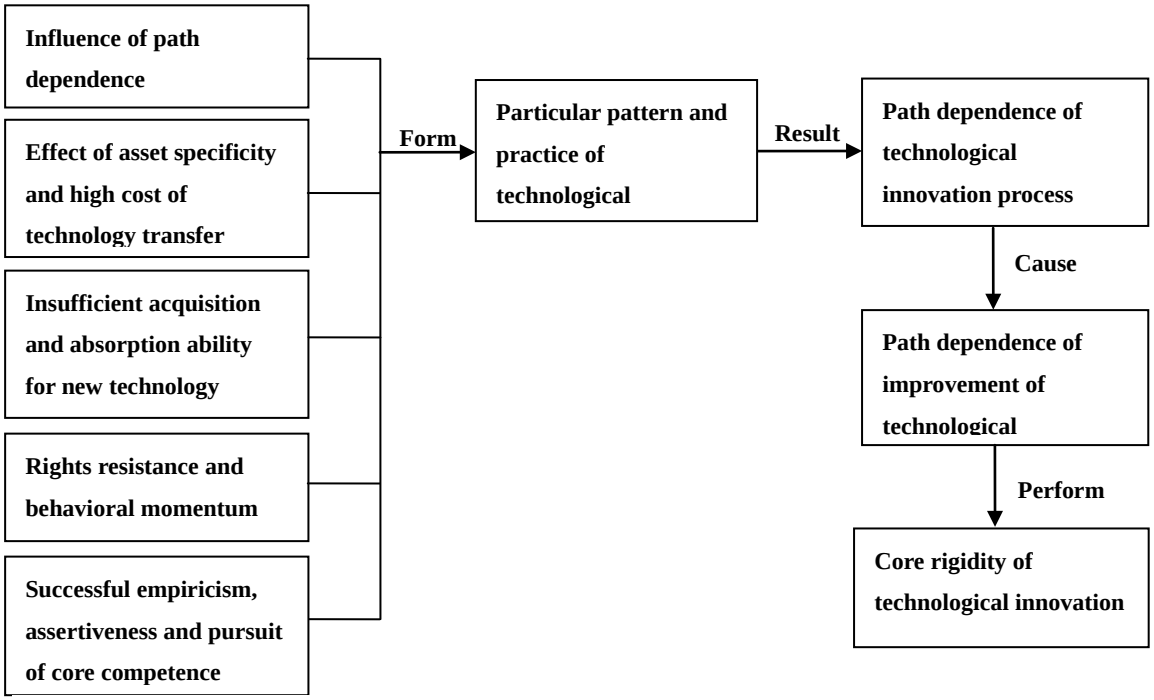


Figure 1: Formation process of technological innovation core rigidity in scientific-technological SMEs.

(1)The influence of path dependence. The research about the path dependence was first put forward by Blain· Arthur (1994). He pointed out that the use of a new technique was often associated with increasing return phenomenon. And a new technology can realize self-reinforcing with the positive feedback mechanism of the early-development advantage. By four kinds of self-reinforcing mechanism, the scale effect, coordination effect, learning effect and adaptive expectations, the more returns of the actions of behavior subject, the more it will be repeatedly used. Thus, the first chosen action is characterized by sequential decision as an advantage "tank", and behavior model was locked in the choice. Although in the short term, each stage of the choice is the optimum, but in the long run, the locking action mode of path dependence is not the best potential action.

When applying the path dependent theory to technological innovation capability studies, we find the following aspects: first, once an enterprise made successful technological innovation through certain models, due to the influence of path dependence, the enterprise will be locked in the technological innovation mode. With the

change of environment, the value of this model may decrease; the enterprise can't escape from this kind of locked state. In the long run, the core rigidity of technological innovation of an enterprise forms. Secondly, although the initial state of mode selected by an enterprise is the best, in the long run, this mode is not necessarily the best choice of potential. We can realize this, but due to the influence of path dependence, it is hard for the enterprise to change existing technological innovation mode, and prevent the company from the harm of technological innovation core rigidity.

(2)The effect of asset specificity and the high cost of technology transfer. According to the principle of microeconomics, production elements can flow fully in a completely competitive market; the allocation of resources can be fully realized through the "invisible hand" –market without any adjustments or transformation obstacles. However, this is only an ideal state. In real economic activities, most investments are characterized by the asset specificity, which leads to sunken cost. Due to the existence of the sunken cost, serious and lasting distortion of resource allocation can be caused both in the totally free competition and regulated market. Sunken cost also can cause core rigid of technological innovation in an enterprise. There are two meanings of sunken cost: one refers to the investment cost of commitment, which cannot get full compensation through transfer price or re-sale value; the other refers to the interest, which can't get compensation once rights promise terminates under contract arrangements. This can also produce sunken cost. In short, sunken costs mean costs that have happened and are unable to recover.

The existence of the sunken cost has produced dual influences on enterprise investment in technological innovation. On the one hand, the existence of the precipitation cost means, to negative investment of mature technology in the later, an enterprise needs to pay for the sunken cost. And the bigger the sunken cost is, the stronger incentive to investment of existing technology is, that is, the rigid is stronger. Therefore, the sunken cost reduces the negative investment and exit incentive of existing technology, resulting in exit barriers. So, at this time excessive investment appears easily. On the other hand, the sunken cost has a negative effect on the entry of new technology. That is, the sunken cost and incomplete information form barriers keeping new technologies from entering into enterprises. Conversely, if the information is complete, sunken cost won't appear, neither will barriers. Because of the incomplete new technology information, enterprise will invest insufficiently worrying about that they cannot get compensation from their investment into new technologies.

In addition, because of technological innovation’s high input and high risk, capital and technology shortage in Scientific–Technological SMEs, if their innovation works, they will make as much use of derivative products and upgrading technology, so as to maximize the profit and take back the cost. Before taking back the cost, Scientific–Technological SMEs often don't want to invest huge capital in new technological innovation, so as to avoid the technology transfer cost, exit cost and decline of innovation revenue, causing financial burden to enterprises.

Through the above analysis, because of the asset specificity effect and the high cost of technology transfer, Scientific–Technological SMEs are more likely to stick with the present technological innovation achievement,

against new technology innovation, thus causing the core rigidity of technological innovation.

(3)Insufficient acquisition and absorption ability for new technology. At present, almost all Scientific-Technological SMEs have not set up perfect information system in China, which is characterized as lacking of dynamic monitoring and tracking system in the technology area of enterprises; and the absorbing ability for new technology is not sufficient either, which keeps new technology concept away from their enterprises when they actually need it, and influence existing technology system, failing to improve and make breakthrough in the existing technologies in time, thereby impede the taking place of innovation changes of enterprises.

(4)Rights resistance and behavioral momentum. When an enterprise makes successful technological innovation mode, corresponding rights and interest structure have established. If the enterprise wants to change the established innovation model with a new one, it is inevitable to harm the rights and interests of managers, and also means that engineers should give up skilled technical expertise and accustomed working ways. This kind of damage to managers' established rights and influence to the employees' behavior habits, become huge resistance to the introduction of Scientific–Technological SMEs' new innovation mode.

(5)Successful empiricism, excessive self-confidence and pursuit of core competence. Scientific–Technological SMEs with successful innovation history often apply and strengthen the original technical model unconsciously, holding their old technology and experience tightly with an attitude that they are the best which cannot be challenged. In addition, once an enterprise gets superiority from their technology innovation, they tend to improve it to the best in the industry. The excessive pursuit to core competence also forms the resistance of the change.

According to the above analysis, we can find that, Scientific-Technological SMEs can obtain independent intellectual property rights and the following core competitive competence, promote the growth of independent intellectual property rights as well as the growth of enterprises through technological innovation. However, as the technology change cycle becomes shorter and shorter in the knowledge economy era coupled with dynamic global competitive environment, core rigidity formed in the process of the technological innovation of Scientific-Technological SMEs will lead that the technological innovation ability of Scientific-Technological SMEs can't match the external dynamic environment，which hamper sustainable and dynamic technological innovation resulting in the loss of impetus for independent intellectual property rights growth, plus the negative influence on technology life cycle and intellectual property law life, eventually the independent intellectual property rights of the enterprise will decay. The other consequence is, Scientific-Technological SMEs will lose their competitive advantage and even wither up in the dynamic environment without the support of technology innovation.

So, the question is how to achieve sustainable technological innovation and keep the independent intellectual property rights growing in the face of increasingly dynamic complex technological and competitive environment; what kind of ability should Scientific–Technological SMEs own, in order to match their technological innovation with the dynamic environment? According to the above problems, this paper, from the dynamic innovation ability perspective, discusses how to realize continuous innovation of Scientific–Technological SMEs, and ensure

continuous growth of the independent intellectual property rights of enterprises, based on dynamic theory and the technical innovation ability theory.

2.3 The characteristic of core rigidity of the technological innovation of Scientific-Technological SMEs.

Once Scientific-Technological SMEs make successful innovation, they often fall into a fixed pattern: On the one hand, the existing technological innovation mode can improve technological innovation ability; it also can reject the formation of new model and generate core rigidity that blocks technological change of enterprises. Facing changing external environment, the core rigid prevents enterprises from building new model in line with market change leading the ability of technology innovation to decline. Normally, this is a fatal blow to Scientific-Technological SMEs, for which must keep accelerating technology innovation under market change, but core rigid hinders the growth of independent intellectual property right of enterprises, even eventually make the enterprise kicked out by the market because of the lost of core competitiveness.

3. Governance mechanisms in technological innovation core rigidity of Scientific-Technological SMEs in China.

Due to the influence of path dependence, the effect of asset specificity, the high cost of technology transfer, insufficient acquisition and absorption ability for new technology, rights resistance and resistance and behavioral momentum and other factors, in the process of technology innovation, the core rigidity of technological innovation of scientific-technological SMEs forms, which can lead the technological innovation of the enterprise can't match with dynamic environment, and enterprises are unable to achieve continuous innovation. So, if scientific-technological SMEs want to realize continuous innovation, technological innovation ability should match with dynamic environment, that is, the dynamic technological innovation.

3.1 Dynamic technological innovation ability of enterprises

Dynamic technological innovation ability, as a kind of dynamic ability, works through integrating, constructing and remodeling internal and external resources and ability of the enterprises to adapt to rapidly changing environment, . This ability gets promoted with the increasing of the ability of capturing market opportunities, and the ability of integrating, constructing and remodeling. For an organization, existing knowledge and accumulated abilities will affect the choice of the subsequent technological innovation activities. Thus dynamic technological innovation ability needs consistent accumulation of technological resources.

This indicates that the technological innovation of an enterprise may happen abruptly based on its long-term accumulated strength. With a relatively small size, scientific-technological SMEs can improve their technological ability by low-end imitation and the accumulation of technology and experience in the process of imitation innovation, laying a solid foundation for enterprise to enter into the phase of independent innovation. Successful technological innovation in other enterprises shows that the successful technological innovation would go through a step-by-step process instead of a simple and independent period. Technological innovation of enterprises are not necessarily sudden and have major technical breakthrough, instead, most of them are

resulting from previous research of low-end imitation and imitation innovation phase, which achieve a new breakthrough from the original technology trajectory, so as to form new technology trajectory, on the basis of constant affirmation of positive results of the original product (service) and production factors.

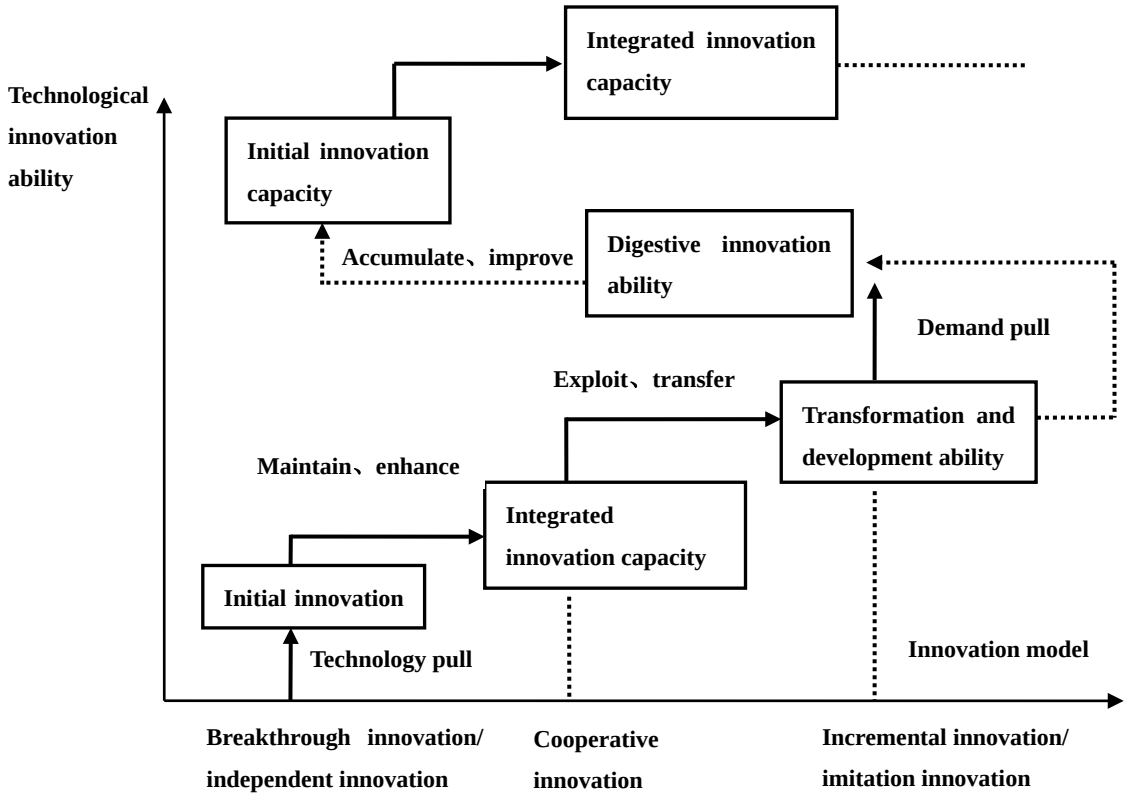
To sum up, each technological innovation needs different technological innovation modes in accordance with its related innovation abilities to form positive interactions.. At the same time, each senior stage is the accumulation and upgrading of the previous stage. According to this, the technological innovation ability and the technological innovation mode of enterprises match with each other and upgrade in ladder-like state.

3.2 Dynamic gradient mode of enterprise technological innovation

Technological innovation of Scientific-Technological SMEs should base on three principles: applicability, dynamic and gradient, aim at improving technological innovation ability, achieving continuous dynamic innovation independently, in order to match with its technological innovation ability level.

The "dynamic gradient" mode of technological innovation of Scientific-Technological SMEs put the above two types of innovation change processes throughout the technological innovation process in enterprises alternately. Through the effective safeguard of intellectual property rights and the support of external support system, circulation accumulation, gradient innovation, dynamic and continuous innovation (as shown in figure 3)of technological innovation ability come true. This innovation mode owns the following two major features.

Figure 3.Technology innovation of scientific-technological SMEs under innovation pattern evolution model



(1) The improving and matching of technological innovation ability of enterprises

Through the above description of alternate promotion of two kind of technological innovation process in the technological innovation process, technological innovation ability of enterprises form gradient ascension process from "the original innovation ability-integrated innovation capacity-transformation development ability-digestion and absorption ability-the original innovation ability" (as shown in figure 3). In this process, if enterprises choose upgraded technological innovation mode compared with its technological innovation capability, the success of the innovation cannot be guaranteed, even has a negative impact on the development of the enterprise; If the selected technological innovation mode is lagged behind the technological innovation ability, it will cause the waste of resources, not an rational choice either. Therefore, only the selected technological innovation pattern match with its technological innovation ability, dynamic, continuous and independent innovation can be ensured.

(2) Dynamic and gradient process of technological innovation in enterprises

Dynamic technological innovation is a progressive, accumulating process, also a non-equilibrium process breaking the original technological balance and forming a new technological balance in order to adapt to the changing environment. Therefore, "dynamic gradient" innovation mode characterized by its dynamic and gradient nature, matches with dynamic technology innovation process, work in coordination with different technological innovation modes, is a suitable choice for the innovation at different enterprise development stages.

At start-up, although their overall level is not high, size small, most scientific-technological SMEs have their pioneer patent technology and innovation ability, which marks the phase with breakthrough innovation technology. Entering the growing stage, due to the increasing accumulation of its pioneer innovation ability, the enterprise has a certain amount of transformation and development ability with the market-oriented incremental innovation becoming its main mode.

At the same time, cooperated with outside institutions such as its chain companies and scientific research institutions, the enterprise further integrate internal and external resources to form integrated innovation capacity, which is the key channel to maintain or strengthen its innovation ability. In its prime, in order to realize the metamorphosis and avoid recession: On the one hand, the enterprises form digestive innovation ability through the imitation innovation and cooperation innovation. They will choose target market purposeful, transfer and develop related business timely; On the other hand, the enterprises form a new and higher level of original innovation ability basing on the ability of independent innovation, forming technological innovation system of structure association, complementary advantages and gradient promotion.

4. Conclusions

We focused on the technological innovation process of scientific-technological SMEs, building an increasing dynamic choice model of technological innovation mode based on technological innovation ability. It should be pointed out that, in real technological innovation process of successful enterprises, there are a variety of innovation modes existing together, the enterprises give priority to one or two modes and choose specific path of

arrangement according to the requirements of the target market and environment; At the same time, the technological innovation ability of enterprises, including the introduction and absorption ability, digestion and absorption ability, integrated innovation capacity, the original innovation ability and so on ,are changing dynamically, Only after comprehensive evaluation, the level of specific technological innovation ability of enterprises in different periods could be figured out.

Through the above analysis, along with the evolution and ascension of technological innovation ability of enterprises, as well as the goal market and the changing environment, scientific-technological SMEs should choose different technological innovation modes, match it with enterprises' technological innovation ability dynamically, and complete the gradient transition to achieve dynamic and sustainable technological innovation.

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