Asian Social Science
www.ccsenet.org/journal.html
Vol. 5, No. 3
March 2009

Research on the Technical Growth Capability of Enterprises and the Countermeasures

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Abstract

In recent years, how to develop enterprise technological capability has become the foremost issue to be tackled without delay in both the theoretical and practical areas. This paper uses a model to testify the non-linear growing law of technological capability in its life circle from the viewpoint of its connotation and growth mechanism, and puts forward specific measures to elevate the technological capability aiming at its traits in different stages of its life circle.

Keywords: Competitive advantage, Technological capability, Life cycle, Technological innovation

1. Introduction

As the key to maintain and strengthen the continuous competitive advantage of enterprises, technological capability (thereafter abbreviated as TC) is the deep-seated soil and fundamental source of enterprise competence. However, the practices demonstrate there isn't any enterprise that develops into giant company in our country with globally competitive power, global market, global trademark of fame and global purchases, which makes how to develop enterprise technological capability (thereafter abbreviated as ETC) become the foremost issue to be tackled without delay in both the theoretical and practical areas during the competition wave of international economic integration. Hence, this paper tries to probe into the cumulative mechanism, and expects to provide certain reference for searching for the upgrading path of ETC in our country by studying dynamically the growth track of TC.

2. The connotation and growth mechanism of technological capability

Since the concept of ETC was advanced, the experts and scholars have made some annotations of its connotation from different viewpoints. Dore (1982) defined TC as the synthesis of the ability to study, create and search for technology, and described it as the chain-typed process including searching for, studying and creating technology emphasizing the role in lifting TC of the learning process and learning capability. While Desai (1984) identified TC from a much wider perspective as the constitution of the capability to purchase technology, operate or run in the factory, copy, expand and innovate. TDRI (Thailand Development Research Institute, 1989) summarized it as the capability to utilize, acquire , synthesize and generate technology according to its maneuverability. Domestic scholars, Wei Jiang and Xu Qingrui(1995), by summing up the aforesaid scholars' definitions, deemed TC as the enterprise capability to acquire advanced technology and information from its surroundings, then combine with internal knowledge to create new technology and information, lastly achieve the innovation and diffusion of technology, and simultaneously store and accumulate the technology and knowledge. Zhao Xiaoqing and Xu Qingrui (2002), from the angle of strategy management, additionally defined it as the summation of the knowledge and skills in field of technological resources and activities. Technological activities mainly include integration and coordination of internal and external technological resources of enterprise organizations, and technological strategy management. Thereby, TC is manifested by technological assets (including hard wares, information system, soft wares and staff skills), organizational structure and processes, external knowledge web, and strategic logic and shared values. Besides, Fransman & King (1984), Sharif (1986), James (1988), and Guo Bin (1998) etc, also separately put forward their understanding of the connotation of

TC.

To generalize the definitions of TC noted above, this paper thinks it should include the contents, both recessive and dominant. The recessive TC refers to the deposited knowledge, capability and experience still un-activated, while the dominant refers to the activated knowledge or capability, such as the existing patent number of the enterprises. Thus, the growth of ETC is essentially the conversion process from the recessive TC to the dominant influenced by a certain assistant mechanism.

3. The growth track of TC evolution in its life cycle

Any technology has its own process of formation, development and disappearance, but its life cycle length not only depends on external changes of surroundings, but also is affected by all kinds of internal institutional arrangements. In order to catch the evolution law in the life cycle of TC, this paper will simplifies its contents into a function supported by the existing technology stock. Thereof, the technology stock unit is the function of the recessive and dominant TC, and the conversion from the recessive TC to the dominant TC is also the process of the augmenting of technology stock units. In addition, when external circumstances are certain, technological innovation usually behaves as the organic combination of two or several technological stock units, herein the paper will suppose the combination includes two units.

Suppose TC in its evolution successively experiences T states: 0→1→2→…t→…→T, 0node of which indicates the state when enterprises firstly get their recessive or dominant TC. t (t=0,1,2…T) node indicates the TC level under t state, and Y_t represents the recessive level, while X_t stands for the dominant level. Just at the node of 0 the number of the enterprise technology stock units is N_0 (Let's suppose $N_0 \geq 2$), while at t, the number is N_t, thereby C_t, the TC level in different stages of enterprises, could be written as:

$$C_t = \lambda \times F(Y_t, X_t) \tag{1}$$

In the aforesaid formula, λ stands for the inherent connecting coefficient of both the recessive and the dominant TC, then in certain environment, much bigger λ illustrates it is much more beneficial to the conversion from the recessive TC to the dominant TC. Moreover, with the gradually maturing of TC in practice, λ would gradually become less. $F(Y_t, X_t)$ would be the relationship formula of efficiency function generated by the recessive TC and the dominant TC under t state. If δ (-1<δ<1) signifies the environmental effect variable(such as the imitation of competitive antagonist), then under general terms:

$$F(Y_t, X_t) = (1+\delta)N_t \tag{2}$$

From the formula (1) and (2), we could get:

$$C_t = \lambda(1+\delta)N_t \tag{3}$$

Therein, when δ>0, it demonstrates the external environment is beneficial to the conversion from the recessive TC to the dominant TC, and at this time TC would tends to ascend. On the contrary, when δ<0, the external environment is not beneficial to this conversion, and at this time TC would tends to suspend or descend. Generally speaking, because of the emergence of new technology or the strengthening of the imitating capabilities of one's competitive antagonists, its growing environmental effect variable, δ, would become gradually less till tends to be minus value, and its overall evolution path could be showed as figure 1.

Without regard to external environmental conditions, ETC would be simply the function of technology stock. In regard to the model of Zheng Yali and Tao Haiqing (2002), suppose the enterprise has the increment of the technological stock units numbered ΔN_t from the node previous to t to t, then we could derive:

$$\Delta N_t = C_n^2 = 0.5N_{t-1}(N_{t-1}-1) \tag{4}$$

For not all the combinations of two kinds of technology stock units would generate new technology, let us suppose the affinity between the technologies is r_s ($0 < r_s < 0.5$), then the formula (4) could be:

$$\Delta N_t = r_s N_{t-1}(N_{t-1}-1) \tag{5}$$

Again because $\Delta N_t = N_t - N_{t-1}$, then we could get:

$$N_t = r_s N_{t-1}^2 - r_s N_{t-1} + N_{t-1} \tag{6}$$

From formula (6), we could conclude, the technology stock in the following state is the multiple of the product between the square of the previous one and r_s, so, by solving this function, we would achieve the general formula of the technology stock at the node of t:

$$N_t = r_s^{f(t)} N_0^{g(t)} + S(r_s) r_s N_0^{D(t)} + E\ (t, N_0, r_s) \tag{7}$$

Therein, $f(t) = 2^t - 1$, $g(t) = 2^t$, $D(t) = 3 \cdot 2^{t-2}$, $S(r_s)$ is a relationship function of r_s, $E\ (t, N_0, r_s)$ is the remainder of t, N_0, r_s.

Let $N_0 = 2$, then suppose the affinity between technologies, $r_s = 0.1$, we could get the time variation figure of the technology stock. Figure2 illustrates technology stock would tends to non-linearly increase by degrees without regard to external environmental terms; the correspondent TC also shows non-linear growing.

However, TC in its self is closely relevant to industrialization, while the industrializing course is essentially the one facing with environmental changes. Therefore, in order to further probe into the influence of environmental changes on the growth of TC, we could get the relationship function of (8) from formula (3) and (7).

$$C_t = \lambda(1+\delta)[r_s^{f(t)} N_0^{g(t)} + S(r_s) r_s N_0^{D(t)} + E(t, N_0, r_s)] \quad (8)$$

We could know from formula (8), the evolution in the whole life cycle of TC, is influenced by not only the technology stock changes, but the internal connecting coefficient (λ) between the recessive and dominant TC, also affected by environmental effect variable (δ). Based on the foregoing analysis, under the synthetic impact of λ and δ, the track of TC evolution would appear in figure 3.

Figure 3 applies the life cycle theory of Iraq ak Maidisi about the subdivision of enterprise life cycle to TC and redefines it to be survival period (fostering period and infancy period), development period (learning period, adolescence period and prime of life period), maturity period (stability period and elite period), recession period (previous bureaucracy period and bureaucracy period), metamorphosis period (death period). Obviously, in different developing stages, the developing states of the product TC are quite different. And the formation, development and decline of TC does not come into being overnight, but evolves along the non-linear curve with qualitative change points and takes on some regularity. From survival period to maturity period, ETC tends to ascend, whose rigidity will strengthen gradually, while entering the recession period, it would tend to descend, and accordingly, whose rigidity would weaken gradually. And every notable ascending or descending of TC will happen at the qualitative change point, which does not represent only at this point could realize the actualization of TC medium or forcing it to let off energy, but realize the transition from quantitative change to qualitative change.

4. TC growth & institutional guarantee of enterprises

According to the aforesaid analysis of TC growth track, its evolution in its life cycle is essentially a process of accumulating and releasing TC medium energy, simultaneously the process of identifying, cultivating, implementing and renewing TC. In order to actuate its successful conversion from recession to domination, and then lengthen its life cycle, it demands for the support of constructing relevant mechanisms and conditions based on the regularity showed in its evolution.

In survival period although the enterprise has had certain technological research capability or technology specialty, TC has not or just been built without prominent technical results and with more slowly technology innovation. It would give rise to shocks when attacked by external environment. Therefore, the foremost task in this stage is to decompose all manufacturing technologies of the enterprise's present products, then classify them according to technology types, carry out fundamental judgment on them by utilizing scientific methods, lastly integrate the resources and elements into the value chain contributing to the lifting of ETC and its further development under its internal or external conditions.

In development period, after continuous trials and corrections of survival period, TC has acquired further development, and the enterprise has had much stronger self-research capability and formed basic technological platform. Thus this period becomes the bottleneck of TC development. It requires that the enterprises need pay attention to markets, enlarge the input of research funds, timely improve the existing technology to ward off the happening of the rigidity or inertia of TC according to the inherent rule of accumulation, guidance and provocation by effective learning management and shaping of innovative corporate culture.

In maturity period, the enterprise technology has attained to an unprecedented level, and TC has been upgrading to maturity, when the enterprise has owned the technology platform that could be continuously enlarged and difficultly imitated, and realized its persistently stable development, which makes further upgrading of TC become very difficult. In addition, the rigidity of TC at the qualitative point of maturity period and recession period will reach by bar the strongest. In the meantime, product technology and manufacturing workmanship have tended to be stable with standardized operation, which makes the focus of competition transfer to cost, price and quality. Besides continuing the tactics of the survival period and development period, the enterprise is required to transfer the emphasis to constructing institutional arrangement beneficial to innovation in order to find new innovation point before entering the recession period.

In recession period, with the influx of new competitive antagonists or changes in market needs (when δ <0), the enterprise's special technology begins to be continually imitated, leading to the devaluation of the existing TC value. At this very moment, on the one hand the enterprise should fully brandish the role of core technology in its present product field to propel the updating of present products and the upgrading and deepening of product lines, on the other hand, it should fully play the role of core technology in the field of exploiting new products so as to generate accruing point of new economic efficacy. Moreover, it could use the changes of technological competitive environment of new product

markets to regenerate and innovate core technology, and lastly by taking in such cooperative organizations as fresh blood or technology-shared strategy alliance to delay the recession period of core technology.

In metamorphosis period, the enterprise has not any innovation capability (λ tends to 0), and the old product technology may have been fundamentally replaced by market requirements. So, if the enterprise wants to keep growing, it should choose appropriate integrating mode to make its core skill and knowledge assembly to change qualitatively, and finally generate new aggregation and innovate new TC as the platform to stimulate core technology, and finally, by which make the enterprise core technology previously surpass the metamorphosis period. Or it should transfer the focus to excavate new core technology and disuse old TC, and by which enter a new recycle of TC life cycle.

5. Conclusions and revelation

The outlook on the life cycle of TC and non-linear evolution track demonstrates that the lifting and accumulating of TC has certain path-dependence and continuality, but sometimes presents certain leaping feature when its own peculiarity or external environment changes. Because the ETC has different externally appearing features in different stages, it should not only have a sober cognizance of TC developing stages, and implement timely and dynamic management aiming at different environment characteristics in different stages, but also be good at adjusting its strategic emphasis and formulating corresponding strategies according to the evolution law of TC, and only by which, could the continuous competitive advantage be formed.

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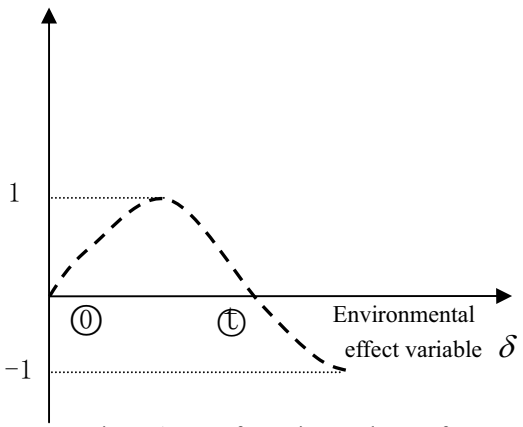

Figure 1. Transformation tendency of
TC growing environmental effect variable

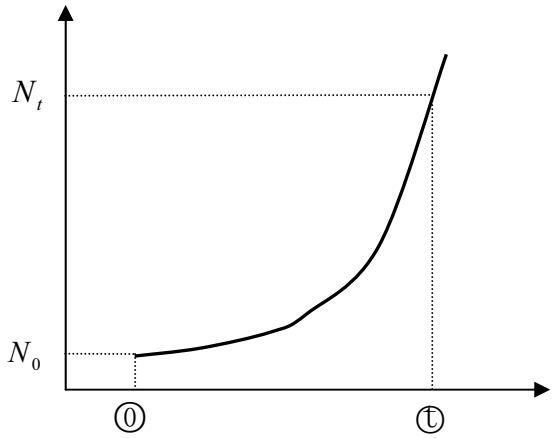

Figure 2. A sketch map of the increasing conditions of technology stock

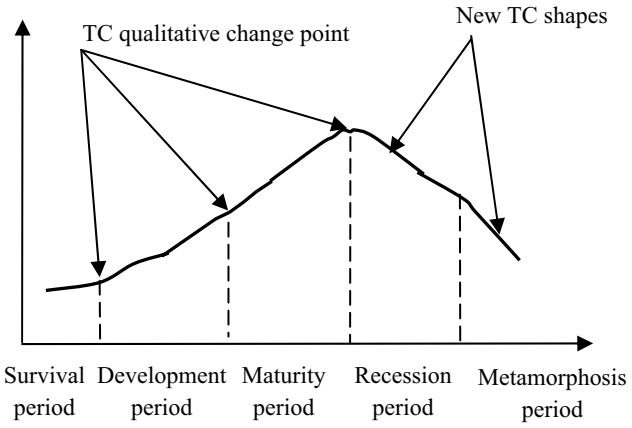

Figure 3. The growth track of TC evolution in its life cycle