Initial Leading Advantages in Firm Competition: A Co-evolutionary Perspective

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Keywords: Co-evolution, Competition, Initial leading advantages.

Abstract. How to survive in the firm competition and make customers arrive at the maximum satisfaction are the important issues in the marketing. Attempting to discuss these issues dynamically, an evolutionary perspective is highlighted and mathematical co-evolutionary models are provided about firm competition. It has been proved that the doctrine of Darwin's the "survival of the fittest" is not a reliable maxim, and the elimination or survival of a firm does not depend on whether it is inferior (weak) or superior (strong), but is closely associated with the initial leading advantages and synergy effect. Therefore, initial leading advantage with contingency and opportunity plays a key role in the marketing competition.

1. Introduction

Darwin's principle of natural selection has exercised an important influence upon social science since the publication of "The Origin of Species". Social Darwinism applying natural selection to human society with emphasis on competition and struggle was endorsed by the advocates of unrestricted competition in private enterprise, the colonial expansionists, and the opponents of voluntary social change[1]. Natural selection, "the survival of the fittest", was accepted to explain the success or failure of firms in market competition, and it has also been taken for granted. However, a kind of contrary phenomena can be seen either in the natural or in the market competition, which is "the survival of the inferior and the destruction of the superior". In the market competition, not only the best technology, products or enterprise can dominate in the market. Examples of such situations are the adoption of the QWERTY keyboard for typewriters, analyzed by David, and the competition between VHS and Beta. These phenomena reflect the complexity of market competition.

In fact, the doctrine of social Darwinism has been gradually criticized by some scholars such as Jacques Novicow, Kropotkin, Dobzhansky and Allen, who generally held that natural selection greatly overstated the fierceness of the struggle for existence[2]. According to these scientists, co-operative forces are biologically more vital than struggle[1]. Kropotkin convinced that the practice of mutual aid has created the conditions of social life. Business ethicists also stress that competition requires cooperation[3]. Therefore, natural selection and Darwinian competition was no longer the indubitable law of the business environment and social society.

Arthur had also demonstrated that the "survival of the fittest" is not a reliable maxim by introducing the dynamic approach of positive feedback, increasing returns, path-dependence and lock-in. He held that the initial advantage got by chance can cause the technology or product or others lock in to an outcome not necessarily superior to alternatives, not easily altered, and not entirely predictable in advance because of positive feedback and increasing returns[4-7]. In the research of economic evolution, some economists such as Hodgson, Winter, and Rosenberg suggest that path dependence exists in the evolutionary process, the initial state may bring the evolution into suboptimal and abnormal road.

In this paper we will prove that the "survival of the fittest" is not inevitable, and the contrary situation "the survival of the inferior and the destruction of the superior" is possible. The elimination or survival of a firm in market competition does not depend on whether it is inferior (weak) or superior (strong), but is associated with the initial advantages and synergy effect. The paper proceeds as

follows. Section 2 analyzes the influence of initial advantages and synergy effect on firm competition. This is followed by constructing a co-evolutionary model of firm competition, from which a conclusion was drawn that “the survival of the inferior and the destruction of the superior” is possible. Finally, we suggest the countermeasures for firms based on the mechanism of impact of initial advantages and synergy effect.

2. Influence of initial advantages and synergy effect on firm competition

The market competition system is a co-evolving nonlinear dynamic system. There are several possible equilibriums in this nonlinear system, rather than a single "optimal" equilibrium. The initial conditions of the system with contingency and opportunity will determine the prioritized equilibrium. Therefore, if a company can grasp this contingency and opportunity in the competition, it will gain a competitive advantage and has a greater chance of achieving the ultimate victory. This competitive advantage is the initial leading advantage of the enterprise, which is usually represented in the initial customer satisfaction. This initial leading advantage is continuously enhanced by the autocatalytic effect of the enterprise, and forms a positive feedback effect, which ultimately enables the enterprise to win in the competition.

Autocatalysis refers to the process of creating the main value of an enterprise. It strengthens the initial leading advantage of the enterprise through four mechanisms. The first is the economies of scale. The economies of scale effect means that the cost of the enterprise gradually declines and the rate of return gradually increases as the scale expands. The second is the rate of technological innovation. A higher rate of technological innovation can accelerate companies to reduce costs, speed up the introduction of differentiated products, and gain a leading advantage. The third is the adaptive learning mechanism, which is the feedback mechanism of the enterprise to the environment during the evolution process. Learning or adaptability refers to “gradually on the basis of the experience of the most frequent response to the past selection receiving more reciprocation[8]”. After the company's products or services are successfully marketed, the company will further improve their products or services. At the same time, the proficiency of workers in mastering new technologies will be improved so that the cost is decreased. The fourth is the synergy between enterprises and consumers. Consumers' attention to certain products often comes from the attitude of the surrounding consumer groups. It will make the market share of products that have already occupied a large market share more higher, which will attract more consumers.

Once the enterprise obtains the initial leading advantage in the market competition, the synergy between the enterprise and consumer will cause more consumers to purchase the products of the enterprise so that to expand the sales volume of the enterprise. The increase in the sales volume can reduce the cost of enterprise through the economies of scale. thereby the profit of the company is increased. Increased profits can encourage companies to invest to carry out technological innovation, which will accelerate the introduction of new products, and improve customer satisfaction. As a result, the enterprise's initial leading advantage is strengthened and more consumers are attracted. This process is shown in Figure 1(A). Increased profits can help to improve the original products and enhance customer satisfaction, which makes the initial leading advantage to be strengthened through the adaptive learning mechanism, as shown in Figure 1(B).

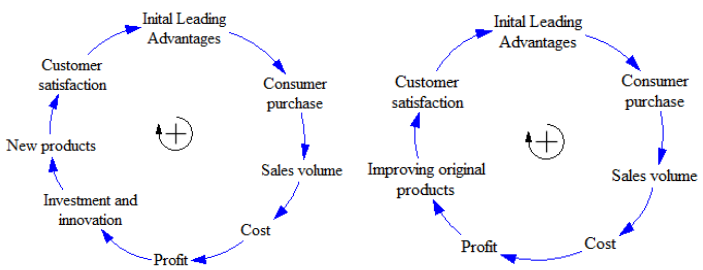

Fig. 1 The Positive feedback effect generated by autocatalytic effect through initial leading advantage of enterprises

3. Co-evolutionary Model of Market Competition

3.1 Introduction of Co-evolutionary Model of Market Competition

It is assumed that there are two firms A and B in the market competition, which research and develop a homogeneous product. X, and Y represent the sales volume of firm A and B respectively, and N is the carrying capacity of possible consumption. There are three catalytic processes for firm A: self-catalytic process (the catalysis of X); market margin catalytic process (the catalysis of (N-X-Y))and the competition inverse catalytic process by B (the inverse catalysis of Y). We will study the following continuous models of firm A and B:

$$dX/dt = a_1 X(N - X - Y) - e_1 Y \quad (1)$$

$$dY/dt = a_2 Y(N - X - Y) - e_2 X \quad (2)$$

Set X_0, Y_0 as the initial purchase got by A and B, which can be expressed as follows, $X(t_0) = X_0$; $Y(t_0) = Y_0$.

$a_1(a_2)$ and $e_1(e_2)$ are the order parameters of generation and extinction evolution of A (B) . When $a_1>a_2$, $e_1>e_2$,A is superior than B. Then A is bound to survival and B is destructed according to the general law of the "survival of the fittest". However, this paper will present rigorous demonstration that the survival or destruction of a firm do not depend on whether it is superior or inferior, but is associated with initial conditions and synergy effect. The initial market share occupied by the firm is full of chances and randomness, thus the "survival of the fittest" would be transformed into "the survival of the inferior and the destruction of the superior".

3.2 Analysis on Co-evolutionary Model of Market Competition

The method for the co-evolutionary analysis is to investigate the singular points of the dynamics co-evolution system composed of equation (1), (2) and initial conditions, analyze their stability, and educe the evolutionary trajectories[9].

By using differential geometry theoretical approach, two singular points for the system can be got[10-11].

$$Q_1 : X = 0, Y = 0;$$

$$Q_2 : \begin{cases} X = (a_2 a_1 e_1 / e_2)^{1/2} N - e_1) / ((a_2 a_1 e_1 / e_2)^{1/2} + a_1) \\ Y = (a_2 a_1 e_2 / e_1)^{1/2} N - e_2) / ((a_2 a_1 e_2 / e_1)^{1/2} + a_2) \end{cases}$$

Moreover, it can be proved that Q_1 is an unstable nodal point and Q_2 is a saddle point no matter what the value of the parameters are. Isoclines and phase trajectory in different quadrants of the phase plane are illustrated in Fig. 2a, and the phase diagram is shown in Fig. 2b.

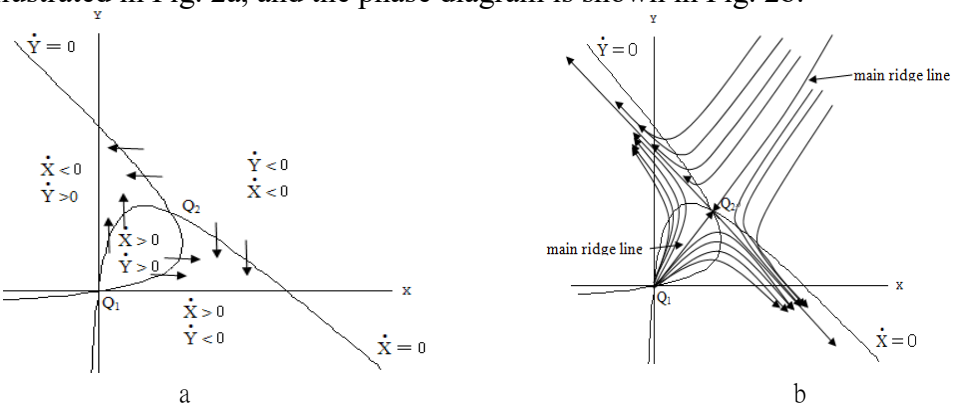

Fig. 2 Co-evolution of Firms in Market Competition

It can be seen from Figure 2b that the phase plane is divided into two parts by the main ridge line. The firm A is eliminated when the initial condition is in the left side of the main ridge line, and B is eliminated when the initial condition is in the right side, no matter which is the superior. Therefore, an important conclusion can be drawn as follows: in the market competition, there is a firm being eliminated before the market does not reach saturation, and the elimination or survival of a firm does

not depend on whether it is inferior (weak) or superior (strong), but is associated with the initial advantages got by chance and synergy effect.

4. Numerical simulation of enterprise competition evolution

It can be seen from the above discussion that when $a_1>a_2$, $e_1<e_2$, A company is better than B enterprise. We will demonstrate the influence of the initial leading advantages in the evolution of the enterprise competition through simulation.

Firstly, we assume that $a_1>a_2$, $e_1<e_2$， (A company is better than B company), that is, the autocatalytic effect of A enterprise is greater than that of B enterprise, and the competitive reverse catalysis of B enterprise to A enterprise is less than that of A enterprise to B enterprise. We will observe who wins by changing the number of consumers initially acquired by the two companies. We set $a_1=0.5$，$a_2=0.2$，$e_1=0.3$，$e_2=0.4$，the result of competition should be that A company wins and B company is eliminated in accordance with the "market competition, survival of the fittest" rule. Assuming N=100, we can observe the impact of the initial conditions on the competition by taking three different sets of initial values. The three sets of values are respectively $X(t_0)=10$, $Y(t_0)=10$; $X(t_0)=10$, $Y(t_0)=30$; $X(t_0)=10$, $Y(t_0)=40$, and the corresponding evolution graphs are: Figure 3, Figure 4 and Figure 5.

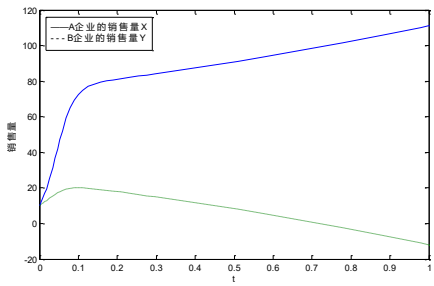

Fig. 3. Evolution of Firm Competition When Initial Value is (10, 10)

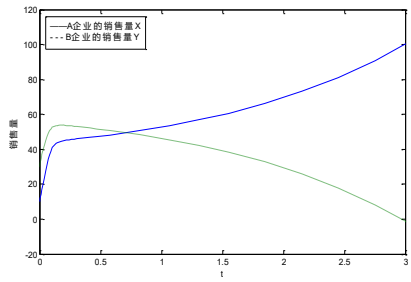

Fig. 4. Evolution of Firm Competition When Initial Value is (10, 30)

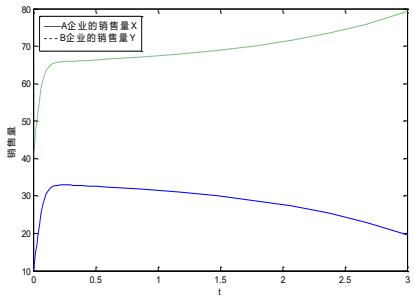

Fig. 5. Evolution of Firm Competition When Initial Value is (10, 40)

5. Conclusion

We have discussed market competition from the point of interrelation between firms and customers in co-evolution theory perspective. In this research we provide a mathematical co-evolutionary model about firm competition. We have constructed system dynamics equations to investigate the doctrine of Darwin's the "survival of the fittest". By analyzing these equations with differential geometry theoretical approach, the Darwin's competition law has been refuted. Thus, we have come to the following conclusion: in the market competition, there is a firm being eliminated before the market does not reach saturation, and the elimination or survival of a firm does not depend on whether it is inferior (weak) or superior (strong), but is closely associated with the initial advantages got by chance and synergy effect. Therefore, initial leading advantage with contingency and opportunity plays a key role in the marketing competition. How to grasp the chances and opportunities for a firm to gain competitive advantages and win in the competition is a significant project for further research.

According to Arthur, “if a product or a company or a technology—one of many competing in a market—gets ahead by chance or clever strategy, increasing returns can magnify this advantage, and the product or company or technology can go on to lock in the market” [8](Arthur 1996). Alfred Marshall had said that "whichever firm first gets off to a good start" would corner the market.

Since the importance of initial leading advantages, firms should strive to gain more customers to obtain initial leading advantages. Firstly, the firm should have a clear understanding to customer demands, and then determine the corresponding marketing strategies in order to achieve the objective of satisfying customers. Then the marketing strategy of the firm should also pay more attention to the influence of product evolution on customer satisfaction degree to create customer demands and implement the creative marketing [10]. Creative marketing means that the companies should go even further than customers. Of course, creative marketing is not the free imagination without customer demands. It should combine with customer demands but not limit with them to guide the customer demands and further enable customers satisfied. Customer satisfaction can improve the firm to innovate actively, which in turn enhance the customer satisfaction.

In conclusion, the initial leading advantages and “the survival of the inferior and the destruction of the superior” make us re-understand the marketing law and pay more attention to the initial advantages of firms. The co-evolution between customer satisfaction and firms’ innovation efforts help the firms recognize the different customers. Firms should do their endeavor to explore potential demand of conservative customers and improve the increasing rate of firms’ innovation to improve customer satisfaction to gain initial customer advantages.

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