Study on the Growth Modes of SMEs among Cluster Based on the Viewpoint of Ecology*

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Abstract: In order to reveal the growth of each enterprises in the SME cluster, business ecology theory and logistic model are used in this paper. By theoretical analysis and model deduction, logistic model can effectively reveal the equalization point and the certain conditions which are needed when reach the equalization point. Therefore, the appropriate countermeasures are proposed for SMEs which can provide the effective theoretical references and support for the development of SMEs.
Key words: SME Cluster; Business ecosystem; Growth Mode; Logistic Model

1 Introduction

The SMEs in China grow up fast, which has been an important part of the modern economic. Scholars have made a lot of researches on this phenomenon and gave answers from different angles. Ichak Adizes (1989) thought that the growth and aging of enterprise are the same as the biological organisms, which has a flexibility in its youth and a controllability of its age[1].Penrose(1959) stressed importance on the endogenous resources during the SMEs growing[2]. Chandler (1977) putted forth that the ability of SMEs' organizational (including equipment and skills in production, sale, management and etc.) is the engine of growth [3].The ability of SMEs' organizational is an integration of the physical plant and personal skills. American economist Moore（1993）put forward the concept of business ecosystem[4]. The business ecosystem is the economic association on the basis of the interactive between organization and individual. Marco Iansiti and Ray Levien（2004）argued that any enterprises in the business ecosystem　shares a same fate as the whole business ecosystem, just as　individual species does in nature ecosystems[5].

Many scholars in our country have carried on research to the SMEs based on the concept of business ecosystem too. Luling(2001) applied the principles of science biological community to analyze characteristics and functions of the business enterprise cluster and community succession and life cycle[6]. Zhouhao(2003) employed the Logistic model in biological studies to describe　the phenomenon of enterprises cluster. He put forwards the crucial point of the enterprises cluster reaching a stable symbiosis is intense competition among the enterprises cluster[7]. Yangyi and Zhaohong(2004) analyzed the ecological link among the enterprises cluster, business Ecosystem, core competencies and coordinated evolution. They established an organization structure of the enterprises cluster[8]. Liuyoujin and Luofayou(2004) studied the ecological characteristics of technological innovation cluster's behavior, and established the analytical frame of it[9]. Hejishan and Daiweiming(2005) showed the condition of achieving balance among cluster members based on ecological theories which is the difference among competitive cluster members[10].

Many scholars have studied the growth modes of SMEs based on business ecology from different angles. But over the past few years most scholars studied the SME's cluster. Few research studied each of enterprises. This article will researches the growth modes of SMEs among cluster with the view of business ecology.

2 Model Hypothesizes

To form a hypothesis that there only exists an enterprise in a market, and the enterprise is hedged around only with limited resources. The Logistic model used in a single biological population can be converted into a evolution model which shows the dynamic change of the increasing output of a enterprise. The model is $\frac{dx}{dt} = rx(1 - \frac{x}{N})$.

Where x(t) is the output of the enterprises' products, assuming that the output is the function of time(t).Many factors affect the output of products and they should change with time(t).Assuming

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resources won't change during a given period of time and area, we define the state that factors and resources of production are made good use and efficient set as natural state(Chen Xuemei, 2003). In this natural state, the biggest output that each enterprise products is N, which means the whole environment restrains enterprises' development. The innate capacity for increase is r, which is not influenced by environment. In Chen Xuemei's paper, she defined r as the average output growth in its business.

Logistic model only gives a description of one product of an enterprise. But in reality it often happens that there are two or more enterprises in an environment. The relationship between them is competition or interdependent or predation. In order to better discuss this problem, this paper only explores the mutual relationship between two enterprises in the SMEs cluster based on the business ecosystems theory. This paper also discusses how to establish enterprise competitive advantage.

From the View Angle of the business ecosystems, the growth modes of enterprises in SME Cluster are competition growth, mutualism growth, autoeciousness growth and prey growth.

The prey growth in SMEs Cluster is seldom. A small enterprise that is not stand out in competition is preyed by a big one or not have a leg up on the competition. So in this paper prey growth is not discussed.

3 Competition Growth
3.1 The Establishment of competition growth Model
Assuming there are two enterprises (enterprise1and enterprise 2) in SME Cluster whose products are replaceable. The relationship between enterprise1and enterprises 2 is competition. When they produce in the same ecosystem, no matter what size, there is competition among them for the sparse resources. The influence is negative direction. So we should deduct an item from $(1 - x/N)$.And we gain the model of enterprise1 (1).Then in the same way, we gain the model of enterprise2 (2).

$$\frac{dx_1}{dt} = r_1 x_1 (1 - \frac{x_1}{N_1} - \delta_1 \frac{x_2}{N_2}) \quad (1) \qquad \frac{dx_2}{dt} = r_2 x_2 (1 - \frac{x_2}{N_2} - \delta_2 \frac{x_1}{N_1}) \quad (2)$$

Where δ_1 is the multiple that a unit of a product of enterprise 1 attract more customers compares to enterprise 2.In the same way, δ_2 is the multiple that a unit of a product of enterprise 2 attract more customers compares to enterprise 1.If $\delta_1 > 1$, enterprise 2 is better than enterprise 1 in the rivalry for customers. If $\delta_2 > 1$, enterprise 1 is better than enterprise 2 in the rivalry for customers.

From the models presented above, we can see that the existence of a marked competition between enterprise 1 and enterprise 2 when they in the same environment. They interact with each other in their output because they struggle for resources required for production. Thinking about (1) and (2),there are (3).

$$\begin{cases} \frac{dx_1}{dt} = r_1 x_1 (1 - \frac{x_1}{N_1} - \delta_1 \frac{x_2}{N_2}) \\ \frac{dx_2}{dt} = r_2 x_2 (1 - \frac{x_2}{N_2} - \delta_2 \frac{x_1}{N_1}) \end{cases} \quad (3)$$

3.2 Analysis on stability of equilibrium state
The equilibrium state is the solution tends to steady as t→∞, as table 1. Here enterprise 1 is stronger enterprise 2,we think $\delta_1 < 1$, $\delta_2 > 1$,which is the first situation in the table 1.We can see easily that enterprise 2 is weaker than enterprise 1 in struggle with enterprise 1's resources. And enterprise 1 is stronger than enterprise 2 in struggle with enterprise 2's resources. So enterprise 2 will inevitably be closed down. And the output of enterprise 1 will reach maximum production, as $(x_1(t), x_2(t))$ will tend to (N_1 , 0). It means that if a bigger enterprise has substitute products and use the same resources when completing in a market with a smaller enterprise, the smaller one will be in decay after operating a lapse of time.

There are two enterprises about the same scale in a market. According to the model above, they can coexistence, and the point of equilibrium is $(\frac{N_1(1-\delta_1)}{1-\delta_1\delta_2}, \frac{N_2(1-\delta_2)}{1-\delta_1\delta_2})$. So if the smaller one wants to

coexistence with the bigger one, it should strengthen the competence by using some kind of strategies, for example market segmentation or selecting target market. Marco Iansiti and Ray Levien said in their book-The Key Advantage-that the creation of value must through various specialized methods. And the specialized methods should be different and persistent.

Table 1   Equilibrium State and Condition of Competition Growth

	equilibrium state	equilibrium condition
The first situation	$(N_1, 0)$	$\delta_1 < 1, \delta_2 > 1$
The second situation	$(0, N_2)$	$\delta_1 > 1, \delta_2 < 1$
The third situation	$(\dfrac{N_1(1-\delta_1)}{1-\delta_1\delta_2}, \dfrac{N_2(1-\delta_2)}{1-\delta_1\delta_2})$	$\delta_1 < 1, \delta_2 < 1$
The forth situation	$(0, 0)$	instability

4 Mutualism Growth
4.1 The establishment of mutualism growth model
Assuming there are two enterprises (enterprise1and enterprise 2) in SME Cluster. The relationship between them is competition just like bee and flower. And their product can be utilized together. When they produce in the same ecosystem, the influence between them is positive direction. So we add an item from $(1-\dfrac{x}{N})$. And then we gain the model (4):

$$\begin{cases} \dfrac{dx_1}{dt} = r_1 x_1 (1 - \dfrac{x_1}{N_1} + \delta_1 \dfrac{x_2}{N_2}) \\ \dfrac{dx_2}{dt} = r_2 x_2 (1 - \dfrac{x_2}{N_2} + \delta_2 \dfrac{x_1}{N_1}) \end{cases} \tag{4}$$

Where δ_1、δ_2 denote the contribution to output of each other respectively.

4.2 Analysis on stability of equilibrium state
Learning from the model above, the condition that two enterprises can be steadily achieve mutualism is $0 < \delta_1 \delta_2 < 1$, and the stabile point is $(\dfrac{N_1(1+\delta_1)}{1-\delta_1\delta_2}, \dfrac{N_2(1+\delta_2)}{1-\delta_1\delta_2})$. But at the stabile point there are $x_1 > N_1, x_2 > N_2$, which cannot be reached. Because the two enterprises is mutuality symbiosis, enterprise 2 is growing with enterprise 1's growth. But they should be synchronous development, which is means that the output of them must on a certain percentage: $\dfrac{N_1 r_1 \delta_1}{N_2(r_1 + r_2 + r_2 \delta_2)}$. It is shows that we should look synchronous development between them as a coordinative development system.

Table 2   Equilibrium State and Condition of Mutualism Growth

	quilibrium state	Equilibrium condition
The first situation	saddle point	$(N_1, 0)$
The second situation	saddle point	$(0, N_2)$
The third situation	$0 < \delta_1 \delta_2 < 1$	$(\dfrac{N_1(1+\delta_1)}{1-\delta_1\delta_2}, \dfrac{N_2(1+\delta_2)}{1-\delta_1\delta_2})$
The forth situation	instability	$(0, 0)$

5 Autoeciousness Growth
5.1 The establishment of autoeciousness growth model

Assumption that enterprise 2 is smaller than enterprise 1, and developed with enterprise 1's. So the development of enterprise 2 is beneficial to enterprise 1. The model is $\frac{dx_1}{dt} = r_1 x_1 (1 - \frac{x_1}{N_1} + \delta_1 \frac{x_2}{N_2})$. For enterprise 2, who depends on enterprise 1, cannot developed without enterprise 1. So the innate capacity of enterprise 2 for increase is negative without enterprise 1. The model is $\frac{dx_2}{dt} = r_2 x_2 (-1 - \frac{x_2}{N_2} + \delta_2 \frac{x_1}{N_1})$.

5.2 Analysis on stability of equilibrium state

From the stable points presented in table 3, we can see that the system will reach a steady value when enterprise 2 becomes a parasite on enterprise 1 and the contribution of enterprise 2 to enterprise 1 is greater than 1 to 2, at that time the output of enterprise 1 reached the maximum. In the third situation showed in table 3, when the contribution to output of each other http://www.iciba.com/respectively/is smaller than 1, so far as $\frac{1-\delta_1}{1-\delta_2} > \frac{r_2}{r_1}$, the system can reach the stable point $(\frac{N_1(1-\delta_1)}{1-\delta_1\delta_2}, -\frac{N_2(1-\delta_2)}{1-\delta_1\delta_2})$.

Here the output of enterprise 2 is negative, which means all output is given to enterprise 1.

Table 3   Equilibrium State and Condition of Autoeciousness Growth

	Equilibrium state	Equilibrium condition
The first situation	$\delta_2 < 1$	$(N_1, 0)$
The second situation	$\delta_1 < 1$, instability; $\delta_1 > 1$, saddle point	$(0, -N_2)$
The third situation	$0 < \delta_1 < 1, 0 < \delta_2 < 1$ and $\frac{1-\delta_1}{1-\delta_2} > \frac{r_2}{r_1}$	$(\frac{N_1(1-\delta_1)}{1-\delta_1\delta_2}, -\frac{N_2(1-\delta_2)}{1-\delta_1\delta_2})$
The forth situation	saddle point	$(0, 0)$

6 Conclusion

In the end, based on such analysis, each enterprise in SME Cluster has a unique growth mode. The small and medium enterprises should choose corresponding strategy according to their own concrete realities and conditions, if they want to make greater progress in the competition.

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