Analysis on the Agent Based Complex Adaptive Growth System of the Small and Medium Enterprises

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Abstract: The growth of the small and medium enterprises is a complex and dynamic adaptive process relating many factors and many performance agents. From the angle of the complex adaptive system, the paper is aimed to construct the systematic analysis framework which consists of many active agents with mutual complex adaptive relations. The systematic analysis framework can reflect the complex adaptive relations among the small and medium enterprises and the related active agents to realize the overall research on the dynamic growth process of the small and medium enterprises. The characteristics of the agent-based complex and adaptive growth system of the small and medium enterprises are also discussed.

Keywords: small and medium enterprises, active agent, adaptive growth, complex adaptive system, growth system

1 Introduction

As an important component of the market economy, the small and medium enterprises (SMEs) contribute significantly to the economic development and social stability in China. The quantity, product and service value, total output and taxation of the SMEs occupied 99%, 60%, 68% and 53% respectively of total enterprises in 2006[1]. The SMEs gradually become the main channel of employment, the important undertaker and beneficiary of the national independent innovation strategy. But, the SMEs in China are in the relative weak position comparing with the large-scale state-owned enterprise. In the growing process, the SMEs encountered the difficulties of the weak competition competence, weak antirisk ability, and short life. It is reported that the average life of the SMEs is only 2.9 years[2] which is lower than 6-7 years of the well-developed countries.

The reasons for the growth neck bottle of the SMEs are not only the limitation of the internal resources, conditions and management, but also the inadequate external environmental supply and service supports. It is necessary to comprehensively analyze the multiagent complex growth system of the SME which can integrate the internal factors and external environment, combine the static factors and dynamic growth process.

2 Methodology of Establishing the Dynamic Growth System of the SME

2.1 Reviews on the growth theories of the enterprise

The thought of the growth theory of the firm is originated from the research on the large scale production by the classical economists. The monograph of “The Theory of the Growth of the Firm” by Edith Penrose in 1959 lays the foundation of the enterprises growth theories. With the diversification of the enterprises practice, the enterprises growth theories become the research emphasis in the economics and management. The development of the growth theories of the SME experienced 3 phases, i.e. elimination of the SME, existence of the SME, and the development of the SME[3]. The growth theories arose different branches, such as the economy-of-scale-based new classical economics [4][5], the new institutional economics with “transaction” essence[6], the endogenic growth theory of the firm[7].

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biological basis life cycle and adaptation of enterprises theories. The growth competency theories are classified into different branches and formed different viewpoints of the competence, such as the concepts of the core competence, dynamic capabilities, and adaptive competence. The growth theories elaborate the growth factors and growth mechanism from different angles, but the integrated theoretical system is not established. The systematic framework of the dynamic growth of the SME, the mutual interactive relations and cooperative growth between the SME and the environment is also not established. Therefore, it is necessary to make deep analysis on the growth system of the SME from the angle of the interactive relationship between the enterprises and the external environment.

2.2 Reviews on the complex adaptive system theory

One of the forerunners of the complexity science, the father of the genetic algorithm, Prof. John Holland, put forwards the overall Complex Adaptive System (CAS) theory based on the active and adaptive agent. From the perspective of the interactive actions between the agent and its environment, the CAS theory unveils the dynamic behaviors of the evolution, adaptation, aggregation, competition, cooperation of the agents in the complex system and explains the mechanism of the diversity, innovation and complexity of the system consisting of the adaptive agents.

The CAS is a complex dynamic system in which the agents can mutually coordinate and adapt, and improve the performance through learning and growth in the development and evolution process of the system. The basic concept of the CAS is the alive and adaptive agent stemmed from the biology. In the CAS, The agent is essentially different from the concepts of the element and the subsystem in the traditional systematic model. The adaptation process of the agent is a process of learning, is also a self-organizational process. The interactive process between the agent and the environment can result in the complex evolution of the differentiation and emergence of the system.

2.3 The concept of the complex adaptive growth system of the SME

As the business environment of the modern enterprises is full of the uncertainty, and because of the diversity of the business action, the growth of the enterprises is a complex and dynamic process of active adaptation to the environment, and pursuing sustainable growth through innovation and reform. Under the analysis framework of the CAS theory, the paper regards the SME as the alive and adaptive agents.

The complex adaptive growth system of the SME can be defines as the complex adaptive system consisting of the alive SME agent with actively adaptive competence, and the other adaptive agents that are closely related to the growth activities of the SME. In the systematic evolution and development process, the actively adaptive agents can improve the performance through learning, derivate the complex mutually adaptive relationship of the attraction, repulsion, resources exchange, duplication through interactive activities, and result in the mutation of the systematic structure.

3 Structure Factors of the Complex Adaptive Growth System of the SME

3.1 Analysis on the systematic structure factors

The structure factors of the complex adaptive growth system of the SME can be simply classified into the internal component and the external ecological environment. The SME located in the central position is the target agent of the growth system, is the carrier of the endogenic growth competence. As an actively adaptive agent, the internal structure of the SME is a living organic system consisting of the subagents, i.e. the department, the project team, the group. In a similar way, the subagent of the SME consists of the subsubagent, i.e. the individual. As a special living organism, the enterprise lives in the macroscopical environment consisting of the natural, population, political, economic, technical, social and cultural factors, and the microscopical environment consisting of the enterprise, supplier, intermediate organization, consumer, competitor, and
the public. The ecological environment of the enterprise is a kind of the multidimensional space weaved by diversified complicated physical network, management network, culture network and relationship network. The basic factors of the ecological environment of the enterprise can be classified into 3 components, i.e. organism, non-organism and special component[22]. The relationship between the SME and its ecological environment is mutual reliance, and interaction.

3.2 Agents of the complex adaptive growth system of the SME
The adaptive agent is the basic concept of the CAS theory, possesses the characteristics of the hierarchy, openness, reaction, adaptation. The analysis of the living and growth environment of the adaptive SME agent should include not only the basic condition of the regional surrounding, but also the alive adaptive agents, which are closely collaborated with the growth of the SME. According to the level of the complex adaptive growth system of the SME, the systematic agents can be classified into 3 types, i.e. the active agent of the SME, the active agents of the ecological environment, and the active agents of the regional environment.
The active agents of the ecological environment of the SME consist of the supplier, the consumer or demanding enterprises, competitor, and complementary enterprise. These enterprises form a complex network with common interest to enlarge the development space, cultivate the innovation competence, develop new product, meet the demands of the consumer through the cooperation and competition. The agents of the regional environment of the complex adaptive growth system of the SME mainly consist of the regional government, university and research institute, the intermediary organization, financial organization and the medium.

4 Structure of the Complex Adaptive Growth System of the SME
According to the tightness of the articulation between the active SME agent and the agents in the ecological surrounding, and the agents of the regional environment, the systematic component of the complex adaptive growth system of the SME can be classified into 3 layers. They are individually the core layer (the first layer), the tight layer (the second layer), and the loose layer (the third layer), as shown in Figure 1.
In the complex adaptive growth system of the SME, the core layer is the endogenic growth subsystem consisting of the internal individuals of the SME, is the fundamental motive force and carrier for the SME to seek for the healthy growth. The tight layer consisting of the enterprise group that establishes the close relationship with the growth of the SME, is the ecological surrounding of the SME, is also the external growth subsystem. The supplier and the consumer or the demanding enterprise with vertical relationship, and competitor, and the complementary enterprise with horizontal relationship structures the enterprise group in the tight layer. In the ecological surrounding of the SME, the SME and the enterprise group form the strategic alliance, supply chain alliance and alliance network through interaction and adaptation, and realize the external networking growth through competition and cooperation. The loose layer is the regional environment that closely relates to the entrepreneurship, existence and growth of the SME, is the supporting subsystem of the SME growth. The active regional supporting agents mainly consist of the organic organizations, i.e. the regional government, university and research institute, intermediate organization, financial organization and medium. The regional environment formed by different supporting agents, can offer the hard and soft environments for the SME growth.
5.1 The non-linearity of the level classification and the systematic emergence

The complex and adaptive growth system of the SME consists of the endogenic growth sub-system, the external growth sub-system, and the growth supporting sub-system. The interaction among the adaptive agents among different layer can derivate the nonlinear aggregation effect, and realize the systematic synergetic evolution.

5.2 The openness of the systematic performance

In the growth process, the agents of different layer, or sub-system keep the exchanges of the material, information and energy continuously, and maintain the integrity and steadiness of the systematic structure and function.

5.3 The complexity of the relationship among agents

In the complex adaptive system, each agent is mutually independent and related, can adapt to the complicated environment and condition through internal reform and relationship adjustment, and maintain the coordination and sustainability of the whole system. The complexity of the relationship among different agent is the motive force of the systematic evolution.

5.4 The dynamics of the systematic structure
The complex adaptive growth system of the SME is a system based on the independent behavior and mutual relationship without centralized planning and control. The active agents in the growth network system with the equal position and independent competence can select the joining and withdrawing strategy freely, and results in the dynamics of the structure of the growth system.

5.5 The actively adaptive evolution competence of the agent and system

The complex adaptive growth system of the SME can exist, multiply, and develop through self-organizing, self-learning, and self-adaptation. If the internal mechanism of the system is degenerate, and the external environment deteriorates, the adaptation competence of the SME to the changes of the environment is delayed or inefficient, the systematic structure, or the SME network organization will disintegrate to death.

6 Conclusion

According to the CAS theory, the SME can be regarded as an actively adaptive agent with self-learning, self-organizing. From the angle of the interaction among different agents, the multi-agent, multi-level, complex adaptive growth system of the SME can be established. According to the tightness and frequency of the interactive relationship between the active SME agent and other agents, the complex adaptive growth system of the SME can be classified into the core layer, the tight layer and the loose layer. It is the interaction among the actively adaptive agents in the different systematic layer that the growth network organization of the SME can realize the systematic synergetic evolution.

References

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