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The Evolution Conditions of Strategic Emerging Industry System

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Abstract

The strategic emerging industry system is a dynamic system, has openness, non-equilibrium, non stability and fluctuation. On the basis of the Prigogine, the Theory of Dissipative Structure, the paper studies the evolution conditions and operation mechanism of the strategic emerging industry system. The evolution development of system depends on the change of total entropy, (which includes two parts, the internal entropy production d_is and the external entropy flow d_es, namely $ds=d_is+d_es$). In addition, the Brussels model of strategic emerging industry system is established on the basis of Brusselator model. Which explores the relationships of $d_is$and d_es each other in the system. The quantified research on the conditions of dissipative structure of strategic emerging industry system is done a study.

Key words: Strategic emerging industry; Evolution; Dissipative structure

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INTRODUCTION

Full understanding of the connotation of strategic emerging industries calls for two prepositions: "strategic" and "emerging". From the perspective of major, long-term and overall situation and the future, "strategic" refers to the healthy development of national economy and has a long-term effect the pillar of national security; for the adjustment of industrial structure and transformation of economic development, it plays a decisive guiding role. "Emerging" refers to the burgeoning relative to the current economic development stage. Technology and industry are both emerging and being deeply integrated. "Emerging" represents the most advanced productivity. Strategic emerging industries in the economic development of a specific phase affect the national economy overall and long-term development, and the strategic emerging industry is less consumption of material resources, large potential market guiding, pillar, good industry.[1] So the understanding of emerging strategic industry should establish an evolution of the "process", instead of the traditional "static view". The dynamic evolution of the development of strategic emerging industry with a high degree of complexity in time and space is influenced by many factors from the internal and external environment of the industry. From the perspective of complex systems, a new theory and way of thinking are used to study the development of strategic emerging industry system. The dissipative structure theory provides a system and new thinking theory for the cultivation of strategic emerging industry development.

The Dissipative Structure Theory created by Prigogine has solved the problem of the orderly evolution of many systems (Nicolis & Prigogine, 1977). In the analysis of physical and chemical, biological system, population system, city system, economic system, The Dissipative Structure Theory is the effective application. The theory on the method by which can judge a system can evolve from the disordered state spontaneously, independently to ordered structure, made important contributions.

[1] The State Council. (2010). Decision of the State Council on accelerating the fostering and development of strategic emerging industries, No.32.

The Dissipative Structure clearly pointed out far from equilibrium and nonlinear that may be the source of ordered structures. If the system is dissipative structure conditions must meet the following conditions (Ren, Zhang, & Song, 2001). First, open system. There are constant exchange with the outside material, energy and information. Second, the open architecture of external input reaches a certain threshold. Third, the system is a nonlinear system away from equilibrium. Fourth fluctuations. Fluctuations are dissipative structures appear trigger, but when it occurs it is unpredictable fluctuations. And when the area of systems is far from equilibrium, fluctuation occurs. The fluctuation is eternal. The fifth non-stability. One aspect of non-stability system instability manifested by fluctuations, reflects the non stability of the system of internal. Internal instability makes fluctuation amplification to achieve the orderly (Xu, 2000). Seen from the collected at home and abroad literature on the cultivation, development of strategic emerging industries, many factors affect the development and evolution of strategic emerging industrial system, but the key factors are as follows: Market demand, Knowledge innovation,Government policy support, Financial system, Talent capital, Scientific and technological innovation and Basic research investments, and so on (Jia, 2012). Scientific and technological breakthrough and innovation, market demand is the inner force of the development and evolution of strategic emerging industrial system; External power is the integration of a variety of resources: government policy support, information, finance, and personnel. This article from the point of view of the dynamic system, the strategic emerging industry system is composed of resources subsystem, market innovation subsystem, technology innovation system and industrial competitiveness system. Each subsystem plays different role in different periods of the development of strategic emerging industries system The four subsystems of strategic emerging industry system promote each other. The resources endowment subsystem is an important support for the development of strategic emerging industry system. Market innovation ability subsystem stimulates the creativity and potential competitiveness of strategic emerging industry system. Technological innovation capability subsystem is to improve the competitive advantage and competitiveness of strategic emerging industry system. Industrial competitiveness subsystem determines the status of emerging industries of strategic systems.The relationship between the four subsystems is working together to determine the future development of strategic emerging industry system, and common constraints healthy development of strategic emerging industries system.

Visible the dynamic development of strategic emerging industry system is the different components or capacity subsystems coupling interactive body formation. At different development stages of the strategic emerging industry, due to the uncertainty of market risk, differences between competitive conditions and industry capability, four subsystems require collaboration and competition. In the bud of the development of the industry system, resource integration ability subsystem is the key, and along with the advancement of technology innovation and market gradually perfection, the competitiveness of the industry system gradually forms. The evolution and development of strategic emerging industry system with four conditions Prigogine's dissipative structures: the system is open; the elements of the various subsystems promote each other, and compete with nonlinear and non balance. In the different development stages of Strategic emerging industry system, the role of each subsystem is different, especially scientific and technological innovation throughout. The dynamic evolution development of strategic emerging industry system is available to the following figure.

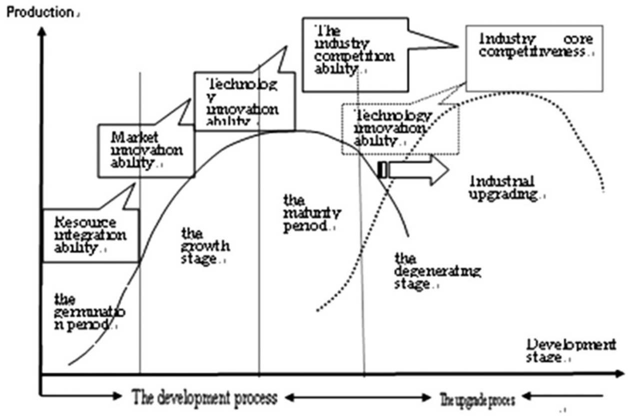

Figure 1
The Dynamic Evolution of Strategic Emerging Industry System

1. THE OPERATION MECHANISM OF STRATEGIC EMERGING INDUSTRY SYSTEM

According to the of Dissipative Structures Theory, the entropy of a system S is said that the change of total entropy *ds* in the time interval is composed of two parts (Prigogine, 1978), a part d_is is the entropy production, produced by the internal irreversible process, which is an always-monotonically increasing value, namely the constant $d_is \geq 0$; another part is the entropy flow d_es, which is generated by the system constantly exchanging material, information and energy with the external environment In this paper, the entropy change of strategic emerging industry system is composed of two parts, a part d_is is the entropy production produced by the interaction of the various elements of the irreversible process another part is the entropy flow d_es. In an open system of strategic emerging industry, when d_es growing enough to offset the internal entropy generation, the system will produce a self-organizing phenomenon to form a stable and orderly dissipation structure. According to Prigogine balance equation system entropy, there is (Sun & Li, 2004; Bai & Wan, 2002): $ds=d_is+d_es$(1) and Figure 2.

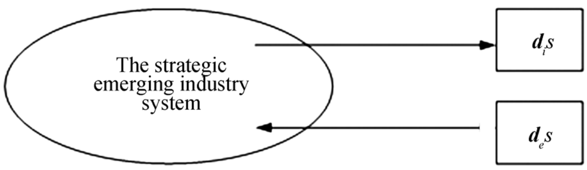

Figure 2
Strategic Emerging Industries System Entropy Flow Diagram

In the initial stage of the development of strategic emerging industries, the degree of disorder within the system is very high, namely the system entropy is in the state of high entropy. At this time it will be entropy generation $d_es=0$;,because of the constant $d_is \geq 0$, according to the formula (1), $ds=d_is\geq 0$ with the entropy generation increases, the degree of disorder within the system will be higher, and finally achieve the complete disorder state. But the strategic emerging industry is not an isolated system with an open system.When the energy, material and information exchange with the outside world, the entropy flow will form. When $d_is<|d_es|$,namely the entropy flow is greater than the internal entropy production, the system evolution gradually tends to be orderly state and eventually forms a dynamic non-balance, stable and orderly structure of state. The concrete operation process is shown in Figure 3.

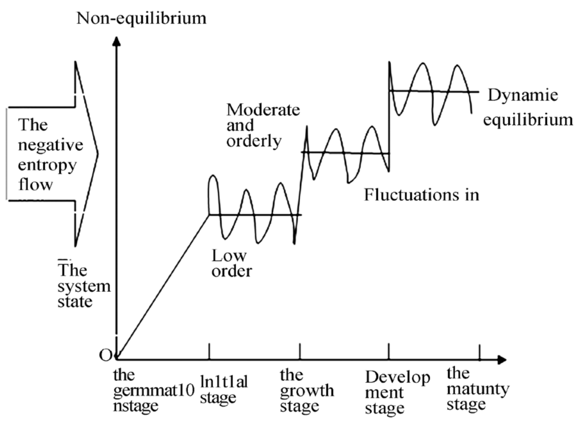

Figure 3
The Evolution Process of Strategic Emerging Industry System

a) The embryonic stage. In the bud stage, The system entropy changes $ds>0$.The beneficial effects of various elements within the system to the system is not strong, may even have negative effects. At this time, there may be $d_es \geq 0$, while the internal system entropy production $d_is>0$. According to Prigogine equation, and the system with high entropy is in a confusion and chaos state

b) The initial stage. At this point the elements which constitute a system constantly exchange material, energy and information with the outside world, have a positive impact on system evolution development. The entropy flow is still not enough to offset the entropy production internal system. But the total entropy gradually decreases, and system operation will appear mutations.

c) The growth stage. With the interaction of various elements of the system continue to improve, enhance the ability of synergistic effect between the elements, and constantly enhance the interaction with the external environment, the system begins to appear orderly organization, the system competitiveness has gradually formed; the system in high entropy state will to be a low entropy state gradually. At this time, the low order system turns further to the moderate orderly evolution, until to form a new dynamic balance. But in the process of dynamic evolution system, the interaction of various elements is not smoothly. The concrete operation process as shown in Figure 4.

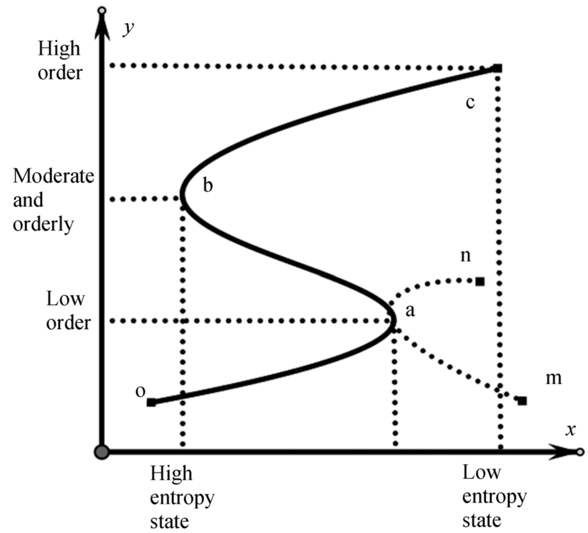

Figure 4
Strategic Emerging Industry System Dynamic Evolution Track

The dynamic evolution development of strategic emerging industry system as shown above: the evolution process of system variables along "chaos—low order--higher order". The state of system moves along the *a—b—c*. Assuming the variable movement equation $y=f(x)$, when the order degree of system evolution increases, the function, status, structure of the system will improve, that is the system tends to be more orderly. From *o* point to *a* point, the role of the system elements appear *a* continuous variation (as shown *oa* line in Figure 3). At this time, the system has not yet entered the order. When the system is the critical *a* point, the state of the system begins to be orderly, *oa* curve shows that system internal entropy production will decrease. The System moves from *o* point to *a* point, which shows that the system evolution appears threshold changes described in the dissipative structure theory. Prigogine said: "in the dissipative structure, after the unstable state the system appeared macroscopically ordered by increasing fluctuation the fastest decision". The fluctuation is the formation of a new structure of lever (Prigogine, 1987). The strategic emerging industry system is a dissipative structure. Dissipative structure is the prerequisite for the development of strategic emerging industries evolution system.

2. THE DISSIPATIVE STRUCTURE MODEL OF THE STRATEGIC EMERGING INDUSTRY SYSTEM

"Brussels model" (Brusselator Model) (Zhang, Cheng, & Zhang, 2010), under the leadership of Prigogine, Belgian Brussels school explored the quantitative analysis method of dissipative structure. Using this model, a quantitative study was made for the producing condition dissipative structure of strategic emerging industry system, and this model was used to determine whether a system became a dissipative structure operable mathematical Model. Based on the Brusselator Model, model of strategic emerging industries system can be established.

$$\begin{aligned} &A \xrightarrow{k_1} X \\ &B + X \xrightarrow{k_2} Y + D \\ &Y + 2X \xrightarrow{k_3} 3X \\ &X \xrightarrow{k_4} E \end{aligned} \quad , \qquad (1)$$

In (1), *A, B* are the initial reactants, and represent self-organization evolution and development of strategic emerging industry system entropy "concentration", respectively the entropy production namely positive entropy, the entropy flow namely negative entropy. *D*, *E* respectively on behalf of the non-dissipative structure and the dissipative structure were said that the system reached the final product of a new ordered structure. *X*, *Y* denote the quantifiable factor of positive entropy flow and the quantifiable factor of negative entropy flow k_1, k_2, k_3, k_4, represent role rate, namely the evolution of "catalyst", the reaction rate coefficients.

According to the method modeling of simple giant system, the dynamics equation of strategic emerging industry system self-organization evolution is established.

$$\begin{aligned} \frac{\mathrm{d}X}{\mathrm{d}t} &= k_1 A - k_2 BX + k_3 X^2 Y - k_4 X \\ \frac{\mathrm{d}Y}{\mathrm{d}t} &= k_2 BX - k_3 X^2 Y \end{aligned} \quad . \qquad (2)$$

In order to simplify the calculation, when the dynamic coefficient is 1, the system dynamic equations will be obtained.

$$\begin{aligned} \frac{\mathrm{d}X}{\mathrm{d}t} &= A - BX + X^2 Y - X \\ \frac{\mathrm{d}Y}{\mathrm{d}t} &= BX - X^2 Y \end{aligned} \quad . \qquad (3)$$

Cubic nonlinearity can be obtained from the above system dynamics equation. The system has nonlinear characteristics of dissipative structure. In the fixed *A, B, D, E* to observe the regularity of $X(t)$and $Y(t)$. Make $\frac{\mathrm{d}X}{\mathrm{d}t} = \frac{\mathrm{d}Y}{\mathrm{d}t} = 0$, the steady state solution of the Brusselator model can be obtained $X_0=A$, $Y_0= A/B$ Near the steady state point ($X_0=A, = \frac{A}{B}$), there is the linear stability analysis of the characteristic equation:

$$\lambda^2+(A^2-B+1)+\lambda+A^2=0. \qquad (4)$$

The stability of the system depends on $A^2 - B + 1$, *A* and *B* as control parameter, the stability of the **system is determined by *A, B* two factors.**

a) When $B<A^2+1$, in the characteristic Equation (4), there are two positive conjugate complex roots.λ_1.and λ_2 are positive root, *X*, *Y* away from the equilibrium point is an unstable node. The steady state point ($X_0=A$, $Y_0= A/B$) as the center is unstable focus point to create a limit cycle, shown in Figure 5.

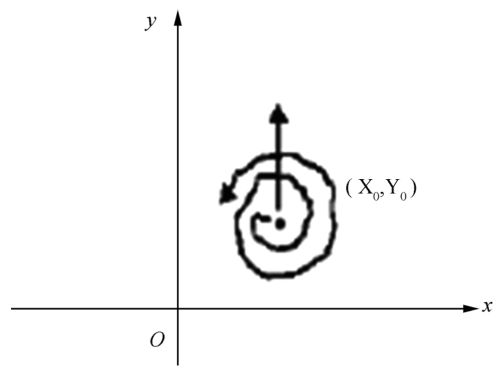

Figure 5
Unstable Focus

b) When $B<A^2+1$, in the characteristic Equation (4), there are two negative conjugate complex roots. The steady state point ($X_0=A$, $Y_0= A/B$) is a stable focus, and the state of system changes from the original chaotic to an ordered state. As shown in Figure 6.

From the above analysis, when $B<A^2+1$, the steady state solution of the system ($X_0=A, Y_0= A/B$) becomes unstable, namely the system may lead to the dissipative structure. Therefore, as long as *A*, *B*, *D*, *E*, k_1, k_2, k_3, k_4, are adjusted and controlled, and $B<A^2+1$, which can make the system far away from equilibrium instability and appears the dissipative structure.

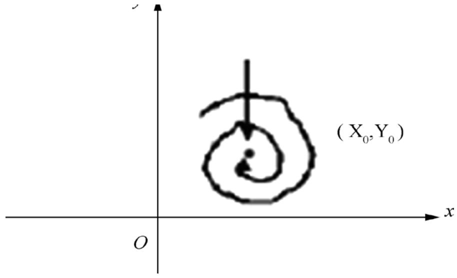

Figure 6
Stable Focus

CONCLUSION

The strategic emerging industry system is a complex dynamic system. In practice, the healthy and orderly development of strategic emerging industry system must constantly gain entropy flow from the outside world. The entropy flow is so large enough to offset the increase of entropy production in this system, and to ensure a higher level, stable, orderly structure evolution of system. The strategic emerging industry is characterized by knowledge innovation and core technology, according to the previous theoretical research conclusions, the essence of the strategic emerging industry system evolution should be continue to increase entropy flow. Therefore, the evolution development of strategic emerging industry requires the joint coordination effect of subsystems and elements of system.

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