# 涵蓋混沌控制於價值鏈的非線性分析

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## 摘 要

微笑曲線近年來被用來說明加值鏈的各種來源已經成爲企業競爭研究的一項工具。然而如何使用適當的量化詮釋於微笑曲線，顯然的十分困難。依據各企業的主要特質，會去研究找到由每一項價值鏈所衍生出加值的分析方法。本文從物流的觀點提出一套量化的數學模式來評估計算衍生的加值。從中國的製鋼產業的資料收集，建立了評估的數學算式，也得到了微笑曲線的特性結果。當每一個價值鏈的行爲出現混沌怪異特性時，從研究分析的結果，建立一套解決的建議方案。本建議方案對中國現代化產業的企業管理會有極大的價值。

**關鍵詞：物流方程式、微笑曲線、混沌、混沌控制**

# Nonlinear Analysis of Value Chain with Chaos Control

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## Abstract

Smiling curve, which is used to explain the source of value-added chain in recent years, has become an important tool in the study of the competitiveness of enterprises. However, how to make appropriate quantitative interpretation of the smiling curve becomes difficult. According to some essential characters in an enterprise, the situations of the added value produced by every activity of value chain are studied to find an analytical method. This paper proposes a quantitative equation from logistic concept to calculate the added value. From data collection from a steel company in China, this paper assesses of the quantitative formula and result with similar feature as the smiling curve. When the chaotic peculiarity of every activity in value chain is considered, some recommendations based on the analysis are discussed in this paper. These recommendations are valuable for modern manufacturing enterprise management in China.

**Keywords: Logistic equation, smiling curve, chaos, chaos control.**

## 1. Introduction

The value chain theory initiated by Michael E. Porter (1998) is an effective tool to study the competitive advantage to enterprises. Its core content decomposes the enterprise value chain into many interrelated activities, such as strategic plan, technological research, product design, manufacturing process and control, logistics service, marketing research and brand construction. Then, it ascertains the cost and added value of each activity, and reconstructs the value chain for the purpose of maximizing value to promote the core competitive advantage of this enterprise.

The former Acer President Stan Shih proposed a "Smiling Curve" (Shih 1992) concept to describe the enterprise stepping into globalization in 1992 as shown in Figure 2. To challenge global competition, intelligent property (IP) and brand are both important to increase the added value of an enterprise, and key to continuing growth and success. Between these two ends, how to manufacture good products will create enterprise's added value in significance. Relating to technology, research and development, product design, and process verification are key knowledge to confront with. Relating to manufacturing, procurement, assembly, logistics and services are sensitive to products. Acer made those joints in perfect match to win the international PC market.

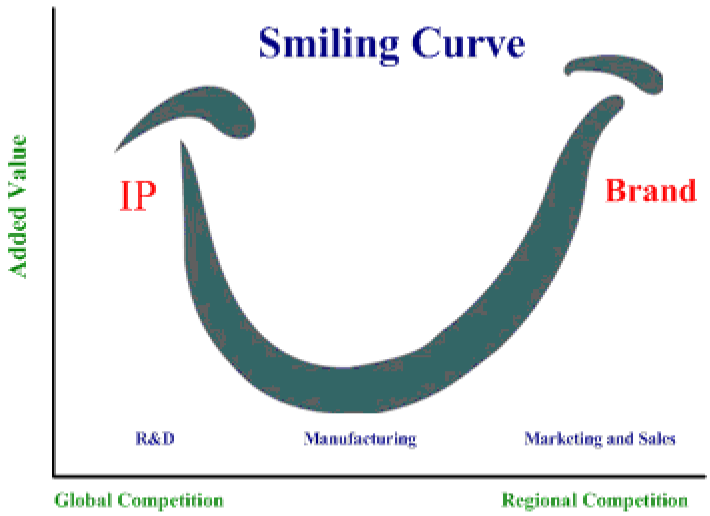


Figure 2: Shih's "Smiling Curve" in 1992.

To the scope of enterprise management, the value chain is an open, complex, and giant system. The existing value chain theory focuses on the static qualitative analysis in certain industries. Kuo and Yu (2006) investigated the present and future challenges for 3G telecommunication system's operators and their advantages based on value chain. Telecommunication system's operators may enroll future development in mobile e-commerce. However, the study on quantitative analysis is little, especially the quantitative methods according to the complex and nonlinear features of the value chain system. The quantitative researches on value chain were focused on value evaluation and the effective design. Housel and Kanevsky (1995) made the extended K-complexity theory to measure the value of incremental production. Evans and Berman (2001) proposed value gap method and the collapse of the chain of transmission methods for measuring the perceived value. This measure performs the value-adding process of the perceived things. Its actual performance is different from the expected performance. Haavardsson and Huseby (2007) developed production models to be used in the broader context of a total value chain analysis. They broke the production model into a sequence of segments, and then represented various discrete events affecting the production in different ways. Additionally, uncertainty may be added to the framework using Monte Carlo simulation (May 1976). Although the study of the value chain has promoted the development of quantitative research, however, there are certain corresponding limitations, such as its model being too complicate. Its supporting data are too difficult to obtain, and its result are too poor relevance from the extended K-complexity theory. The value chain model is simplified by taking average to cancel the effect from sensitive parameters, such as the quasi-production function. It is recommended to ignore the existence of the chaos phenomenon in value chain, but failed to establish detailed chaos control measures.

This paper starts with the essence about the growth of added value gained from value activities and creates a logistic equation of value activities. The related parameters that impact the added value of value activities are studied.

For verification, the relative data of several enterprises manufacturing system are collected and screened to verify the proposed concept, although there are still some difficulties to obtain the exact and supporting data. After converting the collected data, the obtained result appears similar pattern to the real curve.

The preliminary study shows that the growth of the added value in value activities is closely related to system chaos. The chaos control strategy is applied into the traditional value chain management strategy to promote the value chain.

## 2. Added Value on Value Activities

### 2.1 Model for Value Activities

Value chain can be decomposed into several interrelated value activities. Among them, each one can create an added value to the whole value activities. As each activity is regarded as an organic system, its growth and change are self-deterministic and self-adaptive. Value activities can establish relationship with other activities or related external activities to achieve the consistency of the nonlinear optimization. Value activities also achieve the efficiency of their own input-output relationship among coordination to the overall value chain. When the level of added value of the activities reaches to a certain extent, such as getting closer to the limit point, the transition occurs. The overall value chain will get qualitative change and leap to a higher level.

The added value is 0 at the beginning of the enterprise business carve. Therefore, within a certain stage, the level of added value is mainly dependent on the speed of enterprise growth. With limited resources, the added value of each value activity should have its boundary and limitation. The growth of value activity should be closely related to the level of added value that the enterprise has already reached. A function between the growth rate and the level of added value can be expressed as:

$$\frac{dx}{dt} = f(x) * x \tag{1}$$

$f(x)$ is the function of the growth rate of value activity and the level of the added value, and $x$ indicates the level of the current level of added value. Its first derivative $\frac{dx}{dt}$ denotes its added value growth rate.

The more added value approaches to the limit, or the higher level of added value is, the slower its growth rate is resulted. This means that the marginal input effect of the growth of added value is decreasing. When the level is high enough, $\frac{dx}{dt}$ should be negative. When the level of the added value reaches the limit of ***k***, for ***k*** is defined as the limit of value activity's resource. For $f(x)=0$, the simplest function of $f(x)$, which meets the above analysis, can be expressed as:

$$f(x) = p * \left(1 - \frac{x}{k}\right). \tag{2}$$

Therefore,

$$\frac{dx}{dt} = f(x) * x = p * \left(1 - \frac{x}{k}\right) * x, \tag{3}$$

where ***p*** is the growth rate when $k \to \infty$, and is determined by the internal identity of value activity. Separate Equation (3) to get:

$$\frac{dx_t}{dt} = p * x_t * \left(1 - \frac{x_t}{k}\right), \tag{4}$$

with provisions $t \geq 0$, $x_0 = x(0)$.

It is obvious that Equation (4) is the expression of *Logistic equation*. Current status shows that the level of added value is far away from its limit. Since the limit of each value activity is a great value, therefore, the limit can be regarded as basically equivalent to each other. If $0 \leq x_t \leq 1$, the limit of value activity resource $k$ can be taken as 1, Equation (4) then becomes:

$$x_{t+1} = p * x_t * (1 - x_t). \tag{5}$$

Equation (5) is the classic form of *Logistic equation*, which is derived by May (1976).

In addition, if $k$ is a great value, and the level of the added value is far away from the boundary, therefore, $\frac{x_t}{k}$ becomes a minimal value that the growth rate, and is mainly determined by the value of $p$ for the growth rate when $k \to \infty$.

The famous chaos economic model by Day (1982) concluded that:

$$p = \frac{\sigma * A}{1 + n}, \tag{6}$$

where σ is the control intensity parameter for the level of each activity's added value; ***A*** stands for the efficiency of technological advance of the value activity from the Cobb-Douglas production function (Day 1982); ***n*** is the labor growth rate of each value activity.

Based on the simplest form of the Cobb-Douglas production function, the value activity growth rate can be illustrated as:

$$f(k) = A * k^{\beta}, \tag{7}$$

where parameters β is a time function of technological advancement under the condition of the Herouse neutral as:

$$A(t) = A * e^{rt} . \quad (8)$$

Here, $r$ is the parameter of technological advance; for $r > 0$, the technology advances with time; and conversely for $r < 0$, the technology regresses with time; or as $r = 0$, the technology keeps unchanged with time. The Cobb-Douglas production function of the prototype behavior mechanism analysis shows that $A$ can include narrow technological innovation effects, and can also include broadly all of the factors causing the effect of technological progress.

In this paper, the proposed idea substitutes $A = \alpha + \beta$, for $\alpha$ is the technology input growth, and $\beta$ is the technical content parameter, into Equation (8) to get:

$$A(t) = (\alpha + \beta) * e^{rt} . \quad (9)$$

The parameter of $t$ stands for the time interval that the enterprises carry on their business statistics, for example, $t$ may be one year, one quarter, or recent few years, and hence, the parameter can be taken as $t = 1$. This means that Equation (9) can be changed into:

$$A = (\alpha + \beta) * e^{r} . \quad (10)$$

Equation (9) can be considered with Equation (6) to become:

$$p = \sigma * (\alpha + \beta) * e^{r} \Big/ {1 + n} . \quad (11)$$

## 2.2 Value Activity Analysis

The above analysis shows that the main factors to impact the added value level can be summarized as follows.

(1) The control parameter $\sigma$ is applied to the level of added value corresponding to each activity. The regulation and control of every value activity may vary in different enterprises. For example, the Haier Group in China focuses on product design and flexible manufacturing diversification. So, the Haier Group develops a series of green energy products to meet users' demands. In the mid-1990s, the IBM mainly controlled the product design, assembly, and market development; while the Dell strictly controlled the after-sale, distribution, assembly and market development, but with little control to the product design and component production. Almost at the same time, the Compaq did mainly control the assembly and market development, with certain control on the design, without involvement to component production, distribution and after-sale services. The cross analysis of these three computer business is shown as Figure 1.

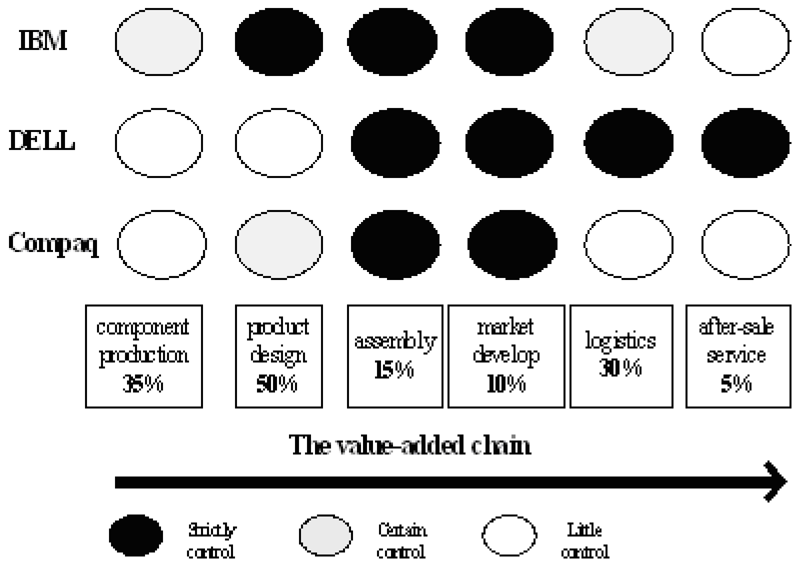


Figure 1: Levels of value chain control of the main USA computer manufacturers.

(2) The technology input growth $\alpha$ can be replaced by research and development (R&D) input growth of every value activity. Technology and capital-intensive sectors usually requires larger R&D input, especially the activities of product design, market research and brand building. They are usually meaningful to the enterprises to establish the competition barriers. Trans Nation Companies (TNC) adjusted the direction of new product development and production based on strategic decision and market response, and established technical R&D centers in China. This change formed a strong competitive advantage and great impact to Chinese enterprises.

(3) The technical content parameter $\beta$ is applied to every value activity. In the intensive management conditions, corresponding to the growth of science and technology, high input usually means high-tech. The level of added value is enhanced from fully tapping the potential of resources and raising the input-output ratio of each resource. This, in turns, can also improve the management level of value chain.

(4) The parameter of technological advance of value activity $\boldsymbol{r}$ includes two aspects, the first as the innovation through research and development, and the second as the introduction of external technical to upgrade technological potential of the enterprise. Independent innovation generally has a long cycle to turnaround with more uncertainty. This needs frequent adjustment according to the market responses and new technical developments. However, the vitality of technological advances is strong, and becomes a bright trend to enterprises. Manufacturing enterprises mostly introduce foreign advanced production lines, using large number of cheap labor in China on those small technology trends of labor-intensive activities, and even behind time as a technical state of regression.

(5) The growth of the labor force in value activities $\boldsymbol{n}$ is professed by the number of employees in the activity each year. Personnel turnover presents small link to research activities, and the size of team is stable. The link of manufacturing is usually with large staff turnover, and if they have more production orders, the high labor force growth will follow.

The current level of added value has consistent growth trend with $\sigma$, $\alpha$, $\beta$, and $\boldsymbol{r}$, except the $\boldsymbol{n}$. The value chain activities are: strategic planning, product technology research design, information systems design, business process design, manufacturing, logistics and distribution, marketing and brand-building, customer service, and etc.

### 2.3 Case Study

In this paper, one steel company in Wuhan, China, is used for analysis. This data collection company is the largest steel company in Wuhan Triangle. The enterprise data are consulted and collected from corporate decision-making departments of production, logistics, marketing, customer service, advertisement by appropriate questionnaires. Some national statistics on Chinese national enterprises are adopted from Ministry of Technical Research and Development and Ministry of Information. Centesimal data are used.

(1) $\sigma$ is a statistical assessment from consulting with corporate departments and referring to national statistics.

(2) $\alpha$ is the annual investment growth rate with the average in the past five years, from corporate statistics as well as national statistics.

(3) $\beta$ is collected through questionnaires from the corporate departments and national statistics of the technical level output.

(4) $n$ is the average growth of employees in the past five years from corporate records and referring to national statistics.

The Wuhan Steel Company is a private enterprise of high growth rate, which is professional in metal materials, construction materials procurement and marketing, over 300 customers nationwide, with annual sale of 7.8 billion Yuan. Its business involves material processing, storage and distribution, starting in 1997. The registered capital is 50 million Yuan. Company's employees contain more than 90% with bachelor or higher degree. The enterprise has become a mainstay "four-star" dealer of Wuhan Iron and Steel Group Company, contractual level agent of Handan Iron & Steel Group, Chuanwei Group, Xiangfan Steel Plant. This enterprise is also credited with "AAA" rank for enterprises, by receiving ISO 9001 quality management system certification standards.

Considering the collected data, the links of strategic planning, technology development and product design, basic manufacturing, logistics and distribution, marketing and service activities, are substituted into Equation (10) to get the results. Due to the difficulties in data collection, $r$=0 is assumed to mean that the technical level is unchanged in a short time study period. The data is analyzed as shown in Table 1.

Table 1: The enterprise links to its growth rate ***p*** in Wuhan Steel.

| Value Activity | ***p*** |
|---|---|
| Strategic Planning | 1.8332 |
| Technology Development & Product Design | 1.1857 |
| Basic Manufacturing | 0.2515 |
| Logistics & Distribution | 0.5017 |
| Marketing & Service Activities | 1.5061 |

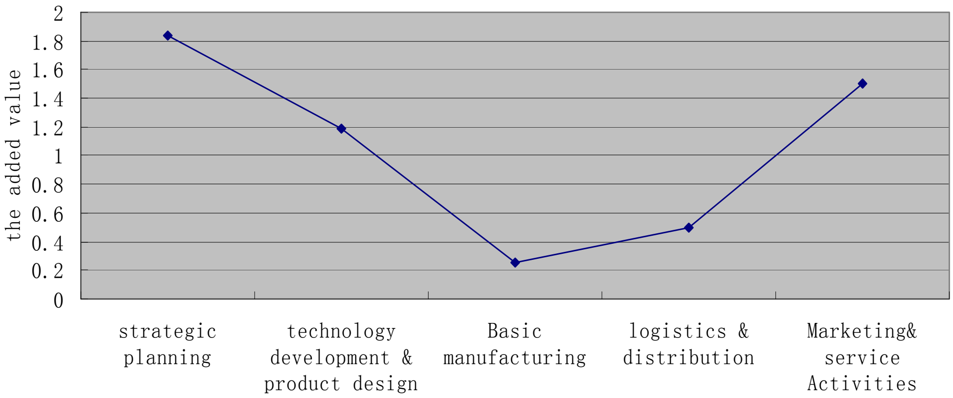


Figure 2: Level of added value in value activities for Wuhan Steel.

Due to the limitations of insufficient enterprise data, it is difficult to assert a consolidate objective in statistics. The resulting data may have some difference to actual enterprise situation. But the trend to this enterprise from the past five year is clear due to (1) the strategic planning activities was the strongest regulation, (2) the capital investment was high and stable, in contrast, (3) employee growth rate was lowest. The control parameters *p* of value-added growth to Wuhan Steel is maximized.

Overview from the facts that (1) the company has just introduced a foreign production line, (2) both technology level and management level are not quite advanced, (3) but its orders are increased that (4) the number of employees maintains high growth rate, the assessment to added value for Wuhan Steel turns out to be low.

## 2.4 Recognizing the Smiling Curve

The shape shown in Figure2 coincides with the "smiling curve" (Shih 1992). Acer developed this new vision for competing in the PC industry based on an extensive analysis of the industry's value-chain (Chen 2004). This vision is summarized in a figure referred to as Shih's Smiling Curve. The smiling curve indicates that the industry's high value added activities were edged out from system design and assembly, which were the traditional core strengths of PC companies such as IBM, Apple and Compaq. Shih's smiling curve illustrated the ongoing dominance of Intel and Microsoft occupies either end of the curve. However, the smiling curve also foretold the success of PC makers such as Dell, Gateway and Compaq who concentrate on design. In fact, in the "smiling curve", it is believed that the enterprises whose concentrate in the core technology research, core components production, brand innovation and the marketing management, are usually more possible to gain higher profit. Relatively, the manufacturing enterprises which lie at the bottom of the smiling curve will gain less profit in the long run.

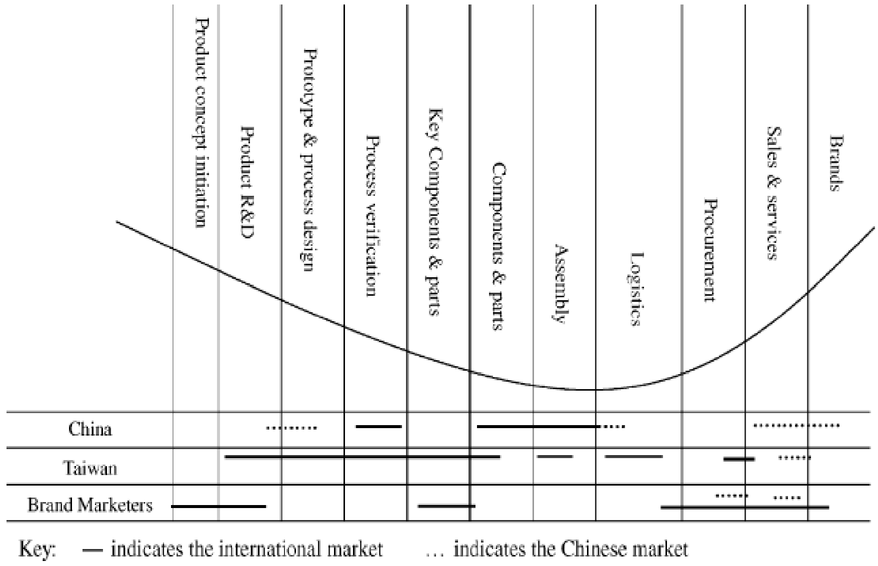


Figure 3: The concept "smiling curve" [9].

The process to enhance the value chain may rely on the effort to upgrade both the right and the left part of the smiling curve. When the links at the bottom of the curve will be transferred to relatively backward regions, the enterprise will turn into a new management level to improve profit.

As to the empirical research, LCD industry in Taiwan is often taken into discussion as case studies (Chiang and Trapper 2007, Huang and Lo 2003). LCD industry is a strong value chain performance comparing to other manufacturing enterprises in the world. For PC and LCD, they are both high tech products of capital-intensive with technology advances. Their added values from value chain analysis are similar.

There are little literature data on industries of similar fast development in China mainland. The Wuhan Steel case and the similar curve will be used as the empirical research in China. However, Wuhan Steel is still a labor-intensive industry. Based on the analysis above, the logistic equation of the value activity can be a quantitative explanation for "Smiling Curve". Difference strategy and value analysis should be applied to Chinese cases to enforce more efforts on value chain management.

## 3. Analysis of Chaos Characteristics of the Value Activity

The incidental chaos characteristics of the above equations brought some inspiration on enterprise management. The *Logistic Equation* is the classical equation of Chaos, which exhibits complex bifurcating and chaotic behaviors of enterprise management. From it, some possible economic implications of the chaos control strategies can be discussed (Chen and Chen 2007).

Consider Equation (5) and Equation (11) to analyze the chaos behavior, some basic assumptions are discussed as follows:

(a) Take the level of added value produced by every value activity $x_t$, as $0< x_t <1$, and linearize the relationship between $x_t$ and the real added value of the value activity.

(b) The range of technology input growth $\alpha$ is 3% ~ 20%; the range of the technical content parameter of every value activity $\beta$ is 10%~30%; the range of employee growth $n$ is 2%~3%.

(c) The divergence figure of $x_t$ and the corresponding control parameter of added value growth $a$ is shown in Figure4 resulting from Mat Lab simulation.

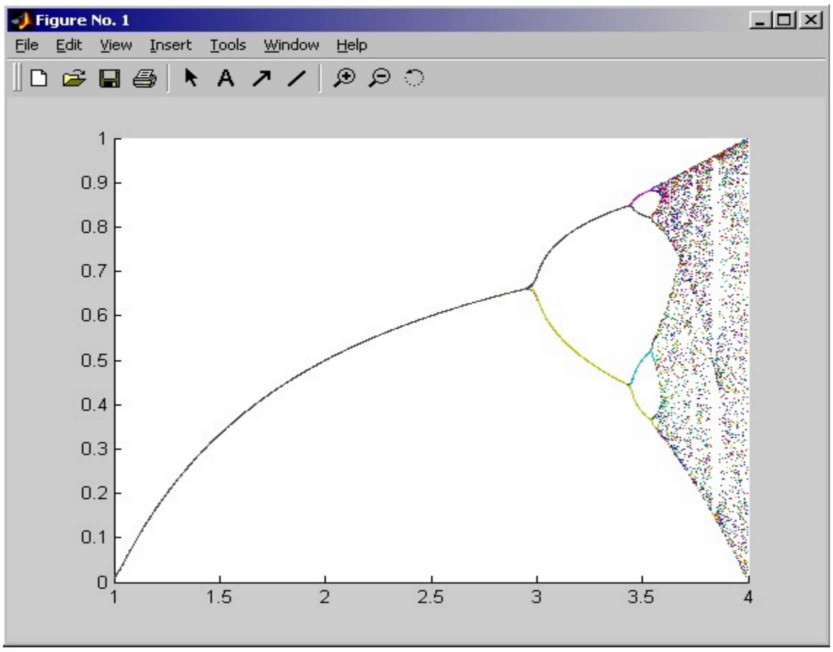


Figure 4: Diverge of $x_t$ and the control parameter of added value growth *p*.

X-coordinate for *p*, Y-coordinate for $x_t$ .

From Figure 4, some basic analysis can be discussed and concluded as follows. The changes of $x_t$ have local structural stability and sexual cycle times diverges. In dynamic economy system, the cycle of a certain economic variable can be regarded as corresponding values nationwide under the premise of fixed control parameter. Specific to the above analysis, the cycle of $x_t$ is only determined by the value of *p*. When diverge occurs, the structure of $x_t$ is not steady.

Referring to Figure 4, the chaos control can be discussed.

(a) When $0<p\leq 1$, the value of $x_t$ is nearly 0, which means that there is no apparent effort and effect in value activity. It is little meaning to control the activity. The value activity of logistics from the above analysis has very little possibility to produce any higher added value quickly. Under such circumstance, the enterprise must take actions to adjust its management structure in order to increase the value of *p*.

(b) When $1<p<3$, $x_t$ has the local structural stability, and its cycle is 1. The scope of $x_t$ is (0, 0.064), meaning that $x_t$ is steady at a certain value in the scope, and there is customer relations between *p* and $x_t$ .

(c) When $p=3$, chart diverge occurs. $x_t$ can be two different values, meaning that its cycle is 2. The structure becomes unsteady.

(d) When $3<p<3.449$, $x_t$ has local structural stability again, however, it can have two corresponding values, meaning that when *p* is fixed, there are two results, and the level of added value can jump on the two results as time passing by. The range of the first result is 0.664~0.85, and the second result is 0.44~0.664.

(e) When $p=3.449$, half diverge occurs, the structure of $x_t$ becomes unsteady again, and its cycle is

4.

(f) When 3.449<$p$<3.544, the structure of $x_t$ is steady again, although there are 4 results of $x_t$, for a given value of $p$. Likewise, cases can be simulated that the cycle of $x_t$ will be 8, 16, etc. When $p$=3.5699, the cycle of $x_t$ will be $+\infty$, which means that chaos has appeared. Under this assumption, the level of every value activities has nothing to do with the value of $p$.

The divergence series of $p$ will decay to a Feigenbaum constant. When sexual cycle times diverge of $x_t$ occur, the divergence series of $p$ will decay to a constant 4.6692, with the value of $p$ increasing.

$$\delta = \lim_{k-\infty} \frac{\mu_{k-1} - \mu_k}{\mu_k - \mu_{k+1}} = 4.6692. \qquad (12)$$

It means that the interval of the divergence values will become smaller and smaller, and the frequency of $x_t$'s sexual cycle times divergence will become higher and higher. If the value of $p$ can be adjusted with high-precision, which makes its value be not near the divergence values, the cycle of $x_t$ will not be changed, and the structure will be kept steady.

In order to observe how can these four indexes, $\sigma$, $\alpha$, $\beta$, $r$, influence the level of added value on a certain value activity's. The values of three out of these four indexes can be determined according to Assumption 2, and change the value of the forth index to simulate the process of changes on $p$. But this is neglected because of the limit of length.

## 4. Some Chaos Control Measures in Value Chain Management

Based on what we have discussed above, the chaos control measures on a value chain management can be summarized as follows.

The concept of chaos control should be properly introduced to enterprise value chain management. It is necessary to master the chaotic features and its law of process from any combination of related elements in realization and enhancement of the level of value activities. Chaos exists in the dynamic process, so it may not be efficient to simply increase the scientific and technological inputs, or to intensify efforts to control. Therefore, it is more prompt to control value chain according to the value of the activity's parameters where dredge occurs. It is efficient to control the value between two dredge values, aiming to keep $x_t$'s local structure steady. Otherwise, it is difficult to guarantee the efficiency of the enterprise value chain management, and even the emergence of management thinking being disordered.

In the initial stage of development, the value of the control parameter representing the level of value activity is still very small. This means that the added value is very low. Therefore, it is necessary to increase the scientific and technological input, to increase the technology content of output, and to intensify efforts to control the value activities, which can increase the value of $p$ quickly. When $p$>1, chaos feature should begin to be considered with some fine-tuning on the relevant parameters.

Further studies show that the level of value activity's added value is practical when $x_t \in (0.5, 0.66)$. If we are simply trapped in the pursuit of the best goals of the results above 0.664, it will only lead to more objective results; even there will be endless objective results. Many objective results mean that the level of value activity may be steady at a high value in the future while it may currently be at a low value. Moreover, this situation is the natural random, and it is impossible to control by value chain management. Therefore, the blind pursuit of high added value in value activities is unrealistic, particularly in Chinese enterprises of low management level. The Chinese enterprises need to establish their own level of added value targets according to the actual value of activities.

As the enterprises enter into mature stage, the employee growth is $\boldsymbol{n}$**<1**, so the level of added value is mainly determined by the scope of technology input growth, the technical content parameter of every value activity, and the enterprise value chain management with regulation and control parameters. This means that the enterprises should make the corresponding policy adjustments aiming at these three parameters. It is profitable to enhance the technical content and financial content, curb the growth of the labor force, and chase the efficiency. Chinese enterprises have their commitment to change from labor-intensive production to capital-intensive and technology-intensive operation to comprehensively improve the level of the value chain.

Initial value sensitivity exists in chaos economy system. Any slight change of initial value may respond a huge change of the whole system's operation. This illustrates that those enterprises should try their best to improve accuracy of statistics, establish relevant statistical indicators, and analyze the data samples informatively and credibly. As a result, enterprises can find the dredge value, which helps them keep the level of added value steady.

## 5. Conclusion

Value chain management is of the scope of enterprise strategic management. Good value chain management establishes significant enterprise competitive advantage and strength. This paper establishes the value activity equation to include most parameters to evaluate an enterprise in better operation in China. The enterprise value depends on the level of value activities' growth rate. Such growth rate is defined according to the relevant factors. However, chaos exists in the process while the enterprise tries to enhance the level of added value. It reflects that some enterprise should manage value chain with the concept of chaos control. There is still step to improve the result because of the inadequate data samples. It is also necessary to collect further supplement to develop theoretical supports and quantitative analyses of value chain performance.

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## 6. References

[1] Chen, L., Chen, G. R. (2007) "Controlling Chaos in an Economic Model", Physica A, (374): 349-358.

[2] Chen, S. H. (2004). "Taiwanese IT Firms Offshore R&D in China and the Connection with the Global Innovation Network", Research Policy, (33): 337-349.

[3] Chiang, T. A., Trappey, A. J. C. (2007). "Development of Value Chain Collaborative Model for Product Lifecycle Management and Its LCD Industry Adoption", International Journal of Production Economics, (109): 90-104.

[4] Day, R. H. (1982). "Irregular Growth Cycle", American Economic Review, (72): 406-414.

[5] Evans, J. R., Berman, B. (2001). "Conceptualizing and Operationalizing the Business to Business Value Chain", Industrial Marketing Management, (30): 135-148.

[6] Haavardsson, N. F., Huseby, A. B. (2007). "Multisegment Production Profile Models - A Tool for Enhanced Total Value Chain Analysis", Journal of Petroleum Science and Engineering, (58): 325-338.

[7] Housel, T., Kanevsky, V. A. (1995). "Reengineering Business Processes: A Complexity Theory Approach to Value Added", Information Value Added, 33 (4): 248-262.

[8] Huang, C. W., Lo, C. P. (2003). "Using Postponed Manufacturing to Reconfigure the Supply Chain in the Desktop Personal Company Industry: The Case of Taiwan", International Journal of Management, (20): 241-256.

[9] Kuo, Y. F., Yu, C. W. (2006). "3G Telecommunication Operators' Challenges and Roles: A Perspective of Mobile Commerce Value Chain", Technovation, (26): 1347-1356.

[10] May, R. M. (1976). "Simple Mathematical Models with Very Complicated Dynamics", Nature, (261): 459-467.

[11] Porter, M. E. (1998). Competitive Advantage: Creating and Sustaining Superior Performance, New York, NY (EUA): free press, ISBN: 0-684-84146-0.

[12] Shih, S. (1992). "Stan's Concept 1992", iD SoftCapital, http://www.stanshares.com.tw.