# Chapter 7

## Complexity of the Agriculture Production Risk Management

We have inquired into a few risk management measures and decision methods of the main agricultural production risk. This chapter will discuss how to make use of these methods from the conception of the system, to take into comprehensive research for various systems of the risk problems, study the system regularity of risk variations and look for the system methods for working out from the risks problems. Actually, because of the system complexity of the risk decision of the agriculture production and the problems of the risk management, we also have much of a necessity to set out the problems deeply.

## 7.1 Introduction of the Risk System Concept

Although the risk problems can be researched from the whole system with many tools of risk analysis and decision methods, the definition of risk system from this angle haven't been discovered [77] [78]. The risk needs to be treated as a complicated system objectively, governments from all the countries also pay attention to the disasters or the important risk problems that may come from economy, society, nature and have examined to build up various of the risk warning and evaluate organizations such as the Information System of the Integrated Risk, IRIS (Integrated Risk Information System) of the Environmental Protection of the United States Agency. The cautious person also pays attention to the several of uncertainty affairs existed nearby and tries to establish to contact them. The risk system complications will give the bad luck to person like the "Satan" of the "Holy Bible". The risk factors have been paid attention by the organization of the professional risk researchers, usually taking profession or profession property. So the production, transmission or spread of the risk is usually widespread contacts or extensively influences each other.

### 7.1.1 The Necessity of Risk System Concept Definition

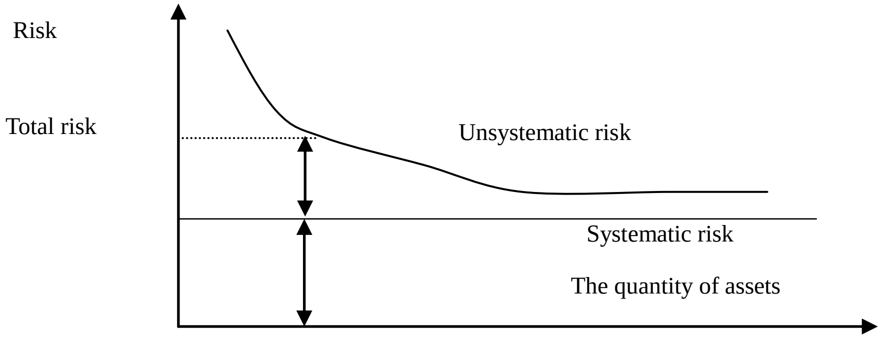


***Figure 7.1*** *Systematic and Unsystematic Risks.*

Build up a concept of risk system, not original "system risk concept", though the existence is difficult, we think it is very necessary. Academic circles have the concept of system risk and non-system risk early [72] [79]. But the system risk is different from "risk system" concept that we have put forward. They think that the system risk comes from the outside of a company, mutually contact such as the war, the economy decline, inflation, financial crisis, high interest rate, politics, economy and society of the risk etc. System risk can't be scattered by making a multi-field investment, so it named non-scatter risk or market risk again. The non-system risk comes from the business activity and finance activity of the company, for example the management level of company, research and development, advertisement of business enterprise, the change of consumer taste and law litigation etc., often can be scattered by a multi-field portfolio, so it can be called scattered risk or the especially company risk. Because the non-system risk completely can be scattered by a reasonable portfolio, the investors always concern of the investing system risk. The relationships of the two kinds of risks are shown below in Figure 7.1.

Actually, in spite of the risk system or the non-risk system all should be considered the problem of a risk management system, should bring all risk factors into the system to carry on a research, as a result, this system theoretically will become the most complicated giant system in structure, it can be called "open complex giant system" (Qian Xuesen, 1989) [48]. This text puts forward regarding the risk problem as an open complex giant system to research, there are two factors should be considered, one is the unity of the risk conception, the other are the contact and conversion of the risk factors. As a matter of fact, before many risks system put forward by scholar can influence the non-risk system on different degrees, this kind of system risk transmitting, spreading will extend the company itself to scatter the so-called "non-system risk" by the reasonable portfolio, but they are not always independent of each other.

The meaning of the risk system conception can be seen with the theories methods. Many references [79] [80] [81] have introduced about the CAPM (Capital Asset Pricing Model), the theoretical prototype has been put forward by the Markowitz, and has been given a development one after another by the Sharpe, Lintner and Mossin etc. Suppose a CAPM model has basic equation as:

$$(R_j - R) = \beta_j (R_M - R) + u_j$$

Among them, the $R_j$ is the income of stock certificate j, the R is the constant income when it has no risk, the $R_M$ is a market income, supposing all of them independent of each other, and the mean value of the random item $u_j$ is 0. Hence, their expected value and variance separately are:

$$E(R_j) = R + \beta_j [E(R_M) - R], \quad Var(R_j) = \beta^2 Var(R_M) + Var(u_j).$$

In the equation, the risks of the stock certificate j include two constituent parts. The first term of the equation right side defined as the system risk, it decided by market risk Var (RM), it is the part that the investors can't evade or scatter, the second term is the special risk of the stock certificate j, it irrelevant other stock certificate in the market, the investor can scatter the risk by various purchase stocks behaviors.

But we find that the total risk is two risks and the investors have to pay attention to the investment decisions of the two risks to adopt. As the conception of risk system, we want to study the total risk (as shown in Figure 7.1). In fact, they are also not independent of each other. If building up a risk system to study risk problem from the different system hierarchies and recognize the system regularity of the risk movement, we can averse and guard against the risk more effectively, and the development of the information network and the modern financial technique also provide the possibility for this research.

The direct meanings which build up risk system conception still lies in the development of market economy, regardless in the global market or in the local markets of all countries, it has been already built up an uncertainty world which is harder to be touched and estimated. An establishment of global risk systems put various of important uncertainty affairs and the possible risk factors into all at prediction and under the guard of world people, putting various risk factors from a nation or region into a big system at the same time, regarding them as an open of sub-system in the big system, aiming at various of risk factors to establish the agriculture risk system, such as the chapter 3, the author has put forward the system methods of the risk identification, strengthening the agricultural risk recognition, supervision and research, it will be good for establishing the decision systems of the macroscopic management of the agriculture risk in China, solving the pity that "for the huge agriculture lack to carry on a research of a macroscopic risk management" (Dong Zhihan, 1999) [82].

Moreover, making use the conception of the risk system also can make the research of the risk problem generalization, and make more general use the technical terms and methods of risk decision [89]. The measure of scatter risk, such as insurance indemnification and so on, is the general measures which are also adopted when making the risk decisions. This result of scatter risk produces more extensively and profound influence inevitable and even includes risk decisions which company or person can control and disperse at original foundation. Actually, since 90's of 20 centuries, the biggest system risk in the world affairs not only adopted the insurance measures of the society dispersion, but also brought huge influence to the finance, trade, politics, diplomacy, science and technology cooperation and even the common civilian's lives.

Therefore, we can regard system risk and the non-system risk factors as research objects, and make them in the different system hierarchy to treating and processing respectively, and from a system perspective to examine the linkages between them, the conversion and transfer. Namely, bring all main risk factors which influenced agricultural development into the opening complex giant system that we defined, make use of the complicated system analysis methods to analyze the factors of risk system, to occur, transmission, spread and remit gather in the risk systems rules, and to evaluate their possible influences to the development of the agriculture or conduct conditions from the whole system. For this, we first should give the definition of the relevant risk system conception:

Definition 1: Global risk system $\Omega$ is a system which is composed of the risk sub-systems $S_i(x) \subset \Omega$ including all the risk factors; $S_i(x)$ is a not-empty set that can be counted, it is decided by the risk factor $x \in \{x \in R^n, S_i(x) \subset \Omega\}$.

So, the global risk system should include nature and ecosystem environment, war and the terror violence, disease, science and technology, economy, trade, finance, politics, diplomacy, law, society, religion, cultural etc. everything have something to do with existence of mankind with society to develop in realm, section, profession or system, possibility and uncertainty factor of disadvantageous or harmful affairs take place is various risk constitute.

Definition 2: The risk system of agriculture production management $S_A(x)$, $x \in \{x \in R^n, S(x)_A \subset \Omega\}$, can be regarded as sub-system or one division of global risk system. What is the aim at all the comprehension of several of undetermined affairs which can influence the circulation of agriculture system and including various risk factors in system oneself in the global risk system?

Once we notice the fast development of the information and the network technique and consider the design of the foreground system, it will not become the difficulty that we can't overcome. In the risk system of the above-mentioned definition, because several of the risk factors are accompany with the commutation of material, energy, information...etc. The system is “open”, because of the system includes a lot of sub-system, thousands, even as hundred millions, it is also named “giant system”. There are many categories of the system in giant system, there are hundreds of kinds, up to thousand and every sub-system not only participation behavior activity of the whole system, but also is influenced by the whole system and environment, producing complicated interaction and is the height non-liner form. And the system has multi-hierarchical structures, the relations of each hierarchy are also very complex as a result, the relations and structures between some hierarchies are still not clear, difficult to understand. At the same time, according to the above-mentioned system definition we can release that not only the global risk system is the giant system, which has an open complex structure, but also agricultural production risk management system is an open complex giant system.

### 7.1.2 The Regularity of the Risk Systems Representation

The movement regulation of risk system really needs to research thoroughly, but from the view of author’s current research, the important risk factors contains some basic movement regulations in the risk system and the occurrence of the important disaster’s affairs can be analyzed and judged according to these regulations. These regulations can be explained with numerous examples.

(i) The risk distributions have systematic hierarchies. The same risk affairs have the influence of different degrees to the different system hierarchies and are called the system hierarchical regulation of the risk distribution. Seen from the Maslow's hierarchy of needs, the uncertainty may exist on the human five need hierarchies, but the risk weights which are brought by the uncertainty affairs is different at different risk hierarchies, The influence of the basic need hierarchies of the risk is more serious, for the enterprise, the strategic decision hierarchy of the risk is usually stronger than the risk of a management control hierarchy, the risk of the management control hierarchy is bigger than the risk of the homework processing hierarchy, for the whole risk system, the world disasters are stronger than disasters of one country, the disasters of one country are stronger than disasters of a regions or section, and the disasters of profession are stronger than a certain business enterprise disasters.

(ii) The variation of the numerous risk factors has caused much more uncertainty and could change the latent risk gather into a great disaster, which is called risk gather. For example, the human body is an open complex giant system, some people because of infecting various diseases, even living in complicated and changed environment or because overwork caused occurrence of fall sick. Another example the occurrence of inflation is not only the soar of one or a few commodity's price level at that time, but also caused by widespread and continuous soar of the commodity price level. The other typical example, the occurrence of the finance turbulence, war of origins, great natural disaster or physics of environment break, the variation of chemistry all have a process from accumulation to coagulate, etc.

(iii) The particularly transmission path which main factors of risk affairs passed can cause occurrence of a series of latent risks or enlargement risk system, cause system disaster at last, it can be called risk transmission. There are a lot of examples in the economy, because a certain small developing country released exchange rate in the open reform process of market economy, does not adopt a valid integration and the result of the financial market exchange rate is undulating, the rate of exchange lost control to make this currency prestige to lower, then it influences to carry on foreign trade normally, especially when there is a shortage of foreign remit and makes use of foreign capital to develop its economy, as a result the country financial system can't resist in the impact of any further foreign country capital, bank break, trade stop and make local finance turbulence by finance and trade outlet influence periphery nation. In the planned economy, because of the false economic instructions to be a pursued hierarchy to reach bottom, the error margin continuously extends and result in serious blind conducted, especially under this kind of system, the leaders like to "report good news not to revenge sorrow" and the information losing reality as a result enlarge the risk.

(iv) An abrupt disaster or risk of remit together can create wave movement, enlarge disaster's influence of the system type and result in the risk spread under the uncertainty condition or through a certain vibration occurrence. The risk spread mainly means extensive and complexity of risk occurrence and influence, particularly the circumstances of transmission path ill-defined. In the economic society, "natural calamity, human's disaster" generally related to this kind of circumstances. In ancient, a big flooded result in the food output reduction significantly, then things would be times of hardship, social unrest, peasant uprising occurred. Now, finance turbulence once occurred, then it will make influence not only in the finance and the trade realm, on the depth it will influence production, employment, life and consuming, via supply and demand of market, local commodity price on the wide degree fluctuation, cross the national boundary and as a result to decline the overall economy.

What we call the regulations of four kinds of various risk systems respectively that are the regulation of the risk distribution, remits gather, transmission and spread. Actually, the movement procedure of risk probably expresses the different regulations on the level of micro and macro view in the system, at most time the movement circumstance of the risk carry interacted across. When considering how to recognize this risk regularity scientifically, the named dense economical theories of risk analytically are met inevitably as follows take the models to inquire respectively.

## 7.2 The Risk System Hierarchical Distribution Model

Open complicated risk giant system can use "functions regiment structure" (Du Jie, 1982) to describe [83]. The function regiment made up of the circle constitutes is more similar with contour line in maps. Such as work segment, workplace, factory, company. The entirely and parts of machine, The social system made up of families, associations and administration organizations etc; The WTO, company, financial group, maritime customs, producer, trade bureau etc. constituted the world trade system. The typical risk hierarchical models are shown as follows in Figure 7.2.

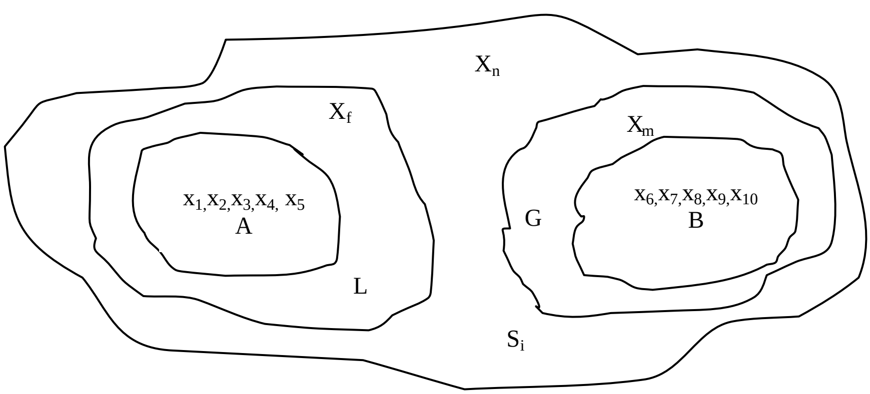


***Figure 7.2*** *Schematic of Risk System Hierarchical Distribution.*

Definition 3: Assume x, Li, Gi, Si $\in$ S, there are systematic element sets:

$$Si=\{x_1, x_2, x_3\ldots, X_n\}, \text{ and } Ai=\{x_1, x_2, x_3, x_4, x_5\};$$

$Bi=\{x_6, x_7, x_8, x_9, x_{10}\}$; and $L_i= \{A_i, X_f\} =A_iUX_f$; $G_i= \{B_i, X_m\} =B_iUX_m$;

Therefore, the sub-set $S_i= \{L_i, G_i, X_n\} =L_iUG_iUX_n$.

If regard every elements of the above-mentioned system as a set of unit element, then the whole system $S \subset \Omega$ is a sub-set group, which power set of $S_i$ generated as:

$$S_i=[\{x_1\}, \{x_2\}, \{x_3\}, \{x_4\}, \{x_5\}, \{X_f\}, \{x_6\}, \{x_7\}, \{x_8\}, \{x_9\}, \{x_{10}\}, \{X_m\}, \{X_n\}, A_i, B_i, L_i, G_i].$$

### 7.2.1 System Structure Tree

Among the element set of sub-sets exist in the relation of including and transmitting, regard every subset as a point, get the tree type structure of that risk system, such as shown in figure 7.3. The structure tree of risk system clearly embody the system hierarchical structure, it also can be called “the hierarchy of system”. For considering every hierarchy accepts risk at different degree, often need to carry on “risk rating of the system”, based on the risk system’s hierarchical rules to define the “hierarchy” concept [45].

Definition 4: The system S is the root of the structure tree, distance from each function regiment or sub-gathering to S is the minimal side of its conjunction number with the diagram theory, namely $d(S, x) = \min N_i$, $x \in S$, among them, the $N_i$ is the number of the side which links S to the xi. Regard each stature as sub-system here, the distance from every sub-system to the S is called its hierarchy, the S is called 0 hierarchy systems in the Figure 7.3, namely d (S,S)=0.

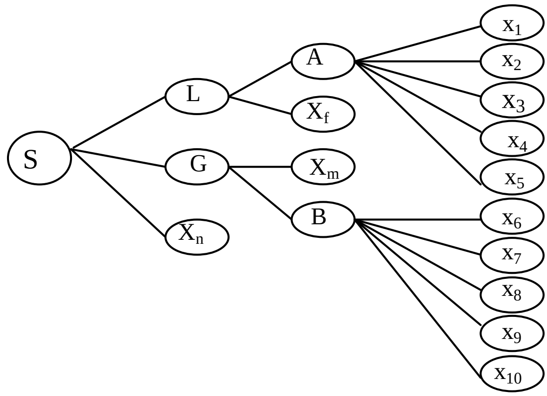


***Figure 7.3***　*Structural Tree of Risk Systems.*

L, G, the $X_n$ is called hierarchy system I, namely $\begin{cases} d(S,L)=1; \\ d(S,G)=1; \\ d(S,X_n)=1. \end{cases}$

A, $X_f$, $X_m$, the B is called hierarchy system II, namely $\begin{cases} d(S,A)=2; \\ d(S,X_f)=2; \\ d(S,X_m)=2; \\ d(S,B)=2. \end{cases}$

{$X_1$, $x_2$, $x_3$, $x_4$, $x_5$; $X_6$, $x_7$, $x_8$, $x_9$, $x_{10}$} is called hierarchy system III, namely d(S, x)=3.

In the structure tree model of risk system, the elements of system is the risk factor, the risk factor distribute according to the system hierarchy, and constantly cross over the boundary to transmit, spread, formative the movement regulation of the hierarchical system. The hierarchical structure of the risk system in the reality may be very huge, complicated, the boundary of sub-system may be unlike the relations in the diagram so clearly and usually have random characteristic, not the boundary line, weakness.

Therefore, carrying on the system description of demonstration usually needs to build up various system assumptions. Make use of the above-mentioned structure tree, and carry out several of relation's operation in gathering element, can expand the structure tree to the m dimension in n hierarchical structure or to express few structures in cent using form dimension.

### 7.2.2 The Management Entropy in the Structural Analysis of the Risk System

#### I. The Creation and Development of System Entropy Conception

The conception of entropy is the foundation of civilization view in 21 centuries [84], it is necessary to retrospect it here, but it has something to do with the definition of physical system. According to the relation of the system and the environment, the physics defined three basic system concepts that are isolated system, closed system and open system at the earliest stage, in order to support establishment of the physics basic laws. The isolated system is the system that is not influenced by the external world, Close system is the system that has energy exchange between system and the external world, but does not have the system of material exchange. But open system, obviously is the system that has not only the energy exchange, but also has the system of material exchange between outside environment and system. But we will discover that these conceptions apparently can't be satisfied to explain physical phenomenon of nowadays information. At the beginning expression of the entropy increasing principle is to regard the natural process as carry on in the isolated system, the information influence is not considered in the meantime.

The conception of entropy already has nearly 170 years. It got from the discussion of the physical thermodynamics system. As early as 19 centuries middle period, the R. J. E. Clausius (1822-1888) had put forward the natural process of "the entropy increasing principle" [85], thought that the natural process is always increasing the entropy. It acted as concrete of expression of the second law of thermodynamics also is called the laws of entropy in the meantime.

Passed a century again, while studied communication system, the C. E. Shannon (1948) put forward the conception of information entropy. As a result of classical information theory in the "old three theories" of system science was born. For pursuing the understanding of science unity, many scholars all once inquired into the inside relations between the physical entropy and the information entropy, especially discovered the consistency on the expression between information entropy and the L. Boltzmann (1844-1906) entropy in the physical statistics.

If investigate the one-way of the thermodynamics macroscopic automatic process, we can regard the hot phenomenon as change process of from appearance of confusion which the degree is small (small probability) to the appearance of confusion which the degree become big (big probability), the entropy expresses this direction of the automatic process and the steps of degree also inevitable related with confusion degree of the molecules moving in the system. L. Boltzmann developed the conception of R. J. E. Clausius at first, put forward statistics physical entropy and built up relations between entropy and probability, and discovered the L. Boltzmann constant ($k=1.38\times10^{-23}$ J/K). We can see, when state the agriculture research mathematics theories within communication, the function of structured information entropy H(p) as "measurement of information, selection and uncertainty", astonishes same as L. Boltzmann entropy.

The aspect of relations between the physical entropy and the information entropy, L. Brilloun (1951) made a great deal of research, once pointed out "the information meant negative entropy", "the information has the function of negative entropy, the information can add to negative entropy of the system". And deduced the same as above-mentioned relations between thermodynamics "entropy" and "information", one ratio especially equal the ten negative sixteen times $E_r/K$. This has revealed the equivalent relations between energy and information. This flow of negative entropy can achieve only under the circumstance that open system, artificial intervention, operation.

Along with the development of system science, the entropy as the tolerance of system complexity has more and more obvious theories meaning. In the 70's of 20 centuries, I. Prigogine of thought of Brussels school put forward the conception of dissipative structural system. Theory of dissipative structural system build up square distance which has not only differentiation but also contraction in these two kinds of different systems of isolated system and open system. Point out, "the variation of entropy" ds of any system can be divided into two parts, "entropy creation" dis in the system and "the entropy flow" des of exchange of system and environment so have:

$$ds = dis + des$$

Among them, the dis is the inner entropy; des is the exchange entropy; the ds is the total entropy of the system. When the system keep off balanced condition, des ‹0 make the system continuously obtain material and energy from the outside environment, bring negative entropy for the system, as a result the addition to make basic properties of the whole system more than the addition of randomness, new structure and new organization can formative spontaneously. This kind of opening system keeps off balanced condition and continuously exchanged material or energy is called "consume to spread structure". Hence, alone the system can just become the especial example of the open system. Rare but happens to have a counterpart, the author of "Synergetic", (Hermann Haken, 1979), of admire be willing to, regard entropy as a measure of the system disorder degree. Hence, consume dissipative structure theories, Synergetic and mutation theories are named "new three theories" in the system science field.

## II. The Application of the Entropy Theories in the Study of Complicated Risk Management System

First, the conception of entropy regardless from the state of information entropy of agriculture and still to see from the angle of statistic's physical entropy, it really included the complex actual meaning, that is uncertainty. Secondly, the conception of entropy has been deep relation with system conception since the day of birth. Though the classical physics has never been regarded the information as his own research object at first, the system that it define has never included the existence of the information conception, but regarding material and energy as standard of exchange relation of system and environment. No longer inquiry here into the relation and philosophy meaning of material, energy and information. But just want to think to combine a management science and methodology and to make use of it in the fulfillment of management science.

The conception of entropy reflected the degree of system uncertainty, and the uncertainty influenced the accuracy of decision and then usually bring into decision risk. We once applied the information entropy to inquiry the risk problem in chapter 4, and the value of the entropy can become "risk degree" of the system loss information. The system structure model of management entropy once is put forward by Song Hualing, Wang Jin etc (1999), their conclusion is: "The hierarchy structure between management efficiency and management objects becomes inverse ratio", "management entropy and structure entropy is positive proportion". Actually, this means that "entropy" is the measure of the complexity of system. The entropy as a widely postpone quantity, the total entropy $S_T$ of system can be expressed by the sum of each parts of entropy S is in the management system [86].

$$S_T = \sum_{i}^{n} \int_{S_i(x)\in\Omega} dS_i$$

In the designing of the system structure, make $S_T$=Min as the standard of its optimizing random structure [87]. In the industrialization operation, we can study the degree of industrial concentration using the structural entropy. The entropy value of the system is much bigger, it means that the system structure more discrete, as the management of risk system is more complex, but if the model is probability structure, the risk of the big entropy value will improve. If it is a production value structure, the risk of the big entropy value will reduce. In total, according to dissipative structure theories, increasing the entropy to improve the system is to add the flow of negative entropy in the system structure, thus the utility of information is leading to a result of negative entropy.

### 7.2.3 The Fractal Structure of the Risk Distribution

The magnitude of risk brought by uncertainty affairs or disaster in different system hierarchy is different, so it often indicates different relations of distribution function. The occurrence of the earthquake for the loss probability in the epicenter region may obey Lognormal distribution, but for the loss probability in the peripheral region maybe normal distribution, and the reproduce the probability interval is possible in Poisson distribution.

System structure or system boundary of the risk distribution can be described by the fractal distribution or fractal geometry in the complicated system, namely cent form dimension number, the brief name cent dimension. The common use and also the earliest cent form put forward by Hausdorff, F. in 1919, it leads to the research of dimension number (cent dimension) by the topological dimension, built up Hausdorff measuring and Hausdorff-Besicovitch Cent. The form expert B. Benoit Mandelbrot of France once suggested describing the complicated degree of curve by the number from one to two. Its definition given as follows. [45]

Supposing $\omega$ is a generous character space made up of gather by all of concerning $x \in \Omega$ of order of a component, appropriately defined the distance of two points, thus defined ball that $\omega$ is a center, ρ is the radius and it permits the degree as 2ρ, while in the dimension d=2, the ball of the radius is ρ, and it permits the degree as $\pi\rho^2$, permitting a degree under the general condition is:

$$\gamma(d)\rho^d = \frac{[\Gamma(1/2)]^d}{\Gamma(1+d/2)}\rho^d, \qquad \Gamma(Euler \quad gamma \quad function)$$

Obviously, to permit a degree is the ball of a non-integral d dimension. Establish supposing the ρ is the Max fixed radius of ball, considering its some coverage $\rho_m < \rho$, which should be limited numbers of small ball radius in a reasonable definition in $\Omega$. For the nature look like of permit of boundary gathering ψ in the $\Omega$. Using the descend extreme limit of $\inf_{\rho_m<\rho}\gamma(d)\sum\rho_m^d$ to express; When take extreme limit ρ to incline toward 0, the expression type $\gamma(d)\lim_{\rho\downarrow 0}\inf_{\rho_m<\rho}\sum\rho_m^d$ namely say "ψ as d dimensional Hausdorff measure". From the viewpoint of expected utility to see, a kind occurrence of disaster is obviously different from losing degree of the person who owns property dissimilarity. Montroll E. W once studied the income in the United States in 30's of 20 centuries, he discovered the income was obeyed the lognormal distribution inside the big scope, but for distribute of 1% high incomes, after through detailed investigation but discover it the Mi index number distribute, namely as $P(x) \propto x^{-1.6}$. Among them, the x is an income level and the P(x) is the population percentage that the income exceeds x. For example, people's income equally turns degree to obviously influence a nation society stability of important factor. A social income allotment can be press the stratum to divide the line, it equally turns the degree in common use Lorenz curve and the Gini coefficient to depict. The Gini coefficient $G^R$ is bigger to express that the income allotment is more concentrated, the more small enunciation income assign more average. If the fractal dimension of income allotment means with the $D_f$, the relation of the Gini coefficient and fractal dimension then cause the expression of the type look like:

$$G^R \approx \begin{cases} 1, & D_f << 1; \\ \dfrac{1}{2D_f - 1}, & D_f > 1. \end{cases}$$

## 7.3 The Risk Gather Model

Nearly risk gather usually is a mutation in the process which the risk factor gradually makes changes. The risk factors make multifarious motion in the risk system, according to the way of its variation, it can be divided into two kinds of the variations (gradually change) of continuous and sudden, discontinuous leap (mutation). Scope of gradually change is small in the unit range time, as a result the risk that is led to easy manage and control. But for some phenomenon of discontinuous leap must be described by several particular shapes. The theory that exclusively use to study discontinuous change, phenomenon of mutation is called Catastrophe Theory [41] [88]. Catastrophe Theory is founded in 1972 by French mathematician René Frédéric Thom at his structure of stability and appearance occurrence learn-set up the mold general theories essentials. It is a newly arisen mathematics which on mathematics theories of differential topology imparts theories and structure stability etc. For a changing system, it probably appears different property, but it isn't decided by estate variable, but decided by discontinuous construction of the number of control variable. Therefore, according to classification axioms of Thom, as long as control variable which caused mutation is more than 5, so control variable altogether have 11 kind of mutation models. If the number of control dimension is no more than 4, the number of appearance dimension is no more than 2 and then the processes of various mutations can be described with these 7 kinds of the most basic mutation models respectively as fold line, cusp, swallowtail, butterfly, oval, hyperbolic and parabola seven types.

For the phenomenon of mutation of the risk gather of risk system can adopt several of models to describe according to the mutation theories, the key is how to handle variation. Almost all superior appearances are all balanced results in the research of accidental economics, such as part balanced and generally balanced. Looking for the economic stability becomes the only target of economic model. The ideal estate that the economics pursue is generally equilibrium, the Walrasian equilibrium has famous Brouwer "fixed point theorem" [26] as certificated; But what political science pursue is usually a social change, so it also has mathematics certificate that social balanced does not exist (V. H Brix, 1989) [89]. Policy and political target are usually lying in adjusting production relation and productivity make them to adapt or make the benefits reallocate. The vary of production relation will take place huge influence for the productivity, this giant variation sometimes is a kind of sharp mutation, so the complicated problem in the economics can use a mutation model to study. Although there are many factors that influence fluctuation of risk system, they can be divided into the two types of direct factors and indirect factors according to the dissimilarity of its influence method. Need to be known firstly, the risks that the natural factors bring have very big contingency or uncertainty, although the natural factors usually cause great disasters, it usually is uncontrolled variable. Suppose we can design two control variables, regard direct factors and indirect factors as two control estate variables, the direct factor means the risk factor in the economy, the indirect factor means political factor etc. We can use a cusp mutation model to make simulation for the mutation phenomenon of the system, and analyze these two control variables to measure the influence which remits to gather to the economic risk.

A cusp catastrophe model: In the model of cusp mutation, according to the control variable of indirect factor is called subdivision factor, but according to the control variable of direct factor is called regular factor. Although direct economic factors to some extent have characteristics of non-integrity, non-reliability and discontinuity etc, it caused that sometimes can't carry on more reasonable beforehand accommodation for the risk variation in the risk system, once at some time or in some district in the future, the economic relation take place sudden change, the risk degree in the risk system may appear discontinuity variation namely mutates. If a very mature and perfect market economic system cannot cause the mutant of the risk system, because direct factor only can cause the continuous variety of risk system, so, the mutation of risk system can affirm to be caused by indirectly environmental factors.

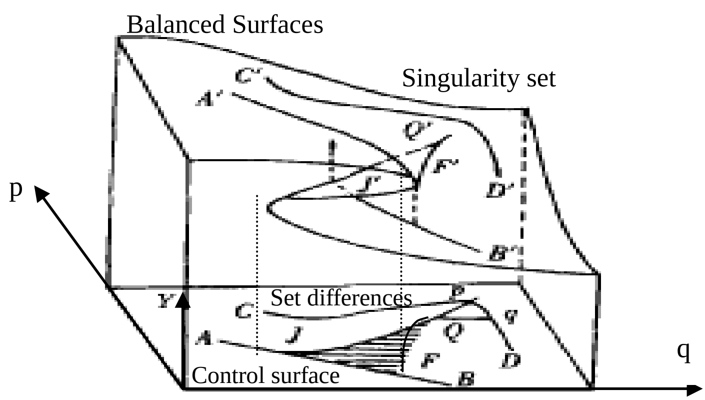


***Figure 7.4*** *Cusp Catastrophe Model of Risk System Aggregation.*

The model of cusp type mutation is mutation model that has more application, its control variables to measure dimension to count to 2, the appearance changes to measure dimension count for 1. Use y, p, q three variables to constitute a 3D state space, with the P and the q set as corresponding horizontal control plane, such as shown in Figure 7.4.

In formula expression, its potential energy function is: $V_{pq}(y)=\frac{1}{4}y^4+\frac{p}{2}y^2+qy$; The general form of balanced curved surface function is: $\frac{d}{dy}V_{pq}(y)=y^3+py+q=0$.

Figure 7.4, the state variation of the system risk is expressed by the topology surface in 3D space, namely the Y balanced curved surface. That peculiar place in the curved surface lie in that it has a smoothly fold, the fold is divided into upper, middle and lower three leafs, it is more narrow more backward, and finally disappear in point Q/ of three hierarchies convergence, is named a critical point. In the study process, We usually believe, the risk system along horizontal gradual processing as a special form. Their projection in the horizontal surface is the control plane, two control variables p and q follows direction of AB continuously change, can see corresponding risk value in the state curved surface follow A/F/B/variation. The balanced curved surface folds area to cast shadow on control flat surface, what to get is one sharp cape form district. It is of the top being sharp and therefore gets a cusp type mutation model.

Mutation theories have been already proved in addition to that fold middle leaf and the whole curved faces all denote the stable estate of risk variety. Therefore, there are two boundaries between stable district and unsteady district and are called “Singular set”. A little bit strange gather to cast shadow be “Divergent set” in controlling curves, at divergent set of two curves cross over point Q. For that model balanced curved surface of singular set and control surface of divergent set to use matrix illustration:

$$\begin{pmatrix} \frac{\partial p}{\partial y} & \frac{\partial p}{\partial p} & \frac{\partial p}{\partial q} \\ \frac{\partial q}{\partial y} & \frac{\partial q}{\partial p} & \frac{\partial q}{\partial q} \end{pmatrix} = \begin{pmatrix} -3y-\frac{9}{y} & 1 & -\frac{1}{y} \\ -3y^2-p & -y & 1 \end{pmatrix};$$

Considering the A′F′B′stage of inception now, the risk value varying continuously descends on the folding leaf, it mean that the system risk is gradually changing, but went to folding edge F′, the control varieties p and q as long as slightly follow AB direction varying, the risk value then will on a sudden fall down the curve surface of district, the occurrence changing in discontinues, this is the risk in the process of descend in the mutation phenomenon. Whereas, if the control changes to measure p and q along the AB contrary direction, namely can see towards the BA direction change, the risk value is under the state curved surface leaf follow B′J′ go up gradually, but arrived folding another edge of J′, then stabilized of continuous curved surface again break off, the risk value has suddenly rise the up leaf of state curved surface, this is the risk value mutation on the rising process.

The mutation of the risk value Y and the other forms of risk system, such as decline first then soar etc. phenomenon also can get better explanation in the model. We can also see in the diagram, if the control variables to measure p, q along the CD curve change, once rounded the cusp type to fold district, and then on the balanced curved surface risk value along C′D′ smooth continuous exchange, will not appear a mutation. Obviously, this kind of situation is the most ideal result of a risk system mutation control.

## 7.4 The Risk Transmission Model

Strictly speaking, the risk transmission and spread are actually two distinguishing concepts. The risk transmission, along particular route from the risk source transmitting to a market, leads to a series of direct possible loss in the process of production management. If the risk transmission route can be clearly described, its transmitting direction and the time space characteristic of occurrence have n dimensions 2 to rush toward structure, can use risk transmission model to study the regulation of risk system. Because under majority of circumstances system may not exist linearity factors, therefore, the risk transmission model have two types of linearity and no linearity. However, the greatly natural disaster not only can result in direct economy loss, but also bring the personnel dead and injured, the disease transmission, inflation and depression, various of disasters act on the process of agriculture production management by many approaches of indirect, the no-linearity and make the utility lower of a long period conduct. The process of risk transmission is usually very complicated, having to ask for help for the processing technique of the form, Fractal dimension can give better description especially when the risk transmission route cannot be described clearly, we defined the risk spread process. In the complicated system, risk transmission and spread always are together as follows we discuss the problems of risk transmission first.

### 7.4.1 Series Risks Transmission Model

When the occurrence of the risk affairs and distribution is independent collectively, the Kolmogorov once proved that the whole rate of system was all decided by an accumulate rate of each statures system. The risk distribution in the system structure establish the hierarchy at this time, for example, the loss rate P of agriculture risk system depends on a series system factors and including the diathesis of agricultural productivity, agriculture technique level, the system of agriculture management, the degree of market perfection, the ability of the agricultural anti-disaster and response of policy etc. Whichever system factor takes place much bigger loss or error will influence the normal function of the whole system and could not reach the schedule target of the system [90].

If the occurrence rates of the subsystem are all independent, suppose that these factors bring into play action in the anti- resist the disaster is normal, its execute rate respectively is: $P_1$, $P_2$, $P_3$, $P_4$… Then:

$$P \propto P_1 \cdot P_2 \cdot P_3 \cdot \cdots P_n = \prod_{i=1}^{n} P_i;$$

Then take logarithms of both sides to get:

$$\lg P = \lg(P_1) + \lg(P_2) + \lg(P_3) + \cdots \lg(P_n) = \sum_{i=1}^{n} \lg(P_i).$$

If each Pi independently takes a limited value, according to central extreme limit theorem, ascend the right side of the type gradually to distribute near the Gauss, so the distribute of P can be called the log normal distribution. In the system, suppose that the rate of each subsystem and hypo subsystem also satisfy above-mentioned distribute regulation, but, we found that equal value and square difference of the positive rate density of the logarithms (the figure of chapter 4.4) can take dissimilarity value, so the variety of risk value R=f(P, C) or expect utility $E(U) = f(E(R), \sigma)$ will express the no-line % form structure. The M rank of the type's system check front and check the Ju is behind respectively is:

$$E(R_s^j) = \prod_{i=1}^{n} E(R_i^j), \qquad E(R_i^j), i = 1,2,\cdots,n; \quad j = 1,2,\cdots,m.$$

### 7.4.2 Parallel Risks Transmission Model

If the relation of each subsystem is parallel in the risk system, the rates that sub-system exerts function are all independent mutually, get probability definition of system with parallel is:

$$P = 1 - \prod_{j=1}^{m} [1 - p_j].$$

In the realistic system, all of the each subsystem usually is not only in series but also parallel. Particularly for big multilevel hierarchical system, all each sub-system with parallel can simplify into a corresponding sub-system.

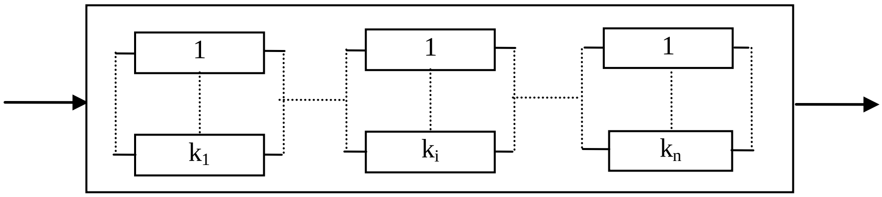


***Figure 7.5*** *System Structures of both Serial and Parallel.*

So for the $k_i$ subsystems in parallel, n subsystems in series, is shown in Figure 7.5. Establishing the performance of the $i^{th}$ hierarchical sub-system's probability is:

$$P_i = 1 - \prod_{j=1}^{k_i}(1 - p_j).$$

Thus press to establish system to treat as series, let $q_i^{k_i} = 1 - P_i = \prod_{j=1}^{k_i}[1 - p_j]$. Then the whole system probability is: $P = \prod_{i=1}^{n}[1 - q_i^{k_i}]$.

In the realistic system, the problem we met mostly is compound systems, which have parallel and series. Such as still take logarithms of the above-mentioned P of both sides, suppose the system is constituted by the n same units, namely a complicated higher moment K/N(G) system [91], from the posterior test of R to get a prior M-order posterior moment is: $E(R_j), j = 1, 2, \cdots, m.$

The system structure function is: $R_s = 1 - \sum_{i=0}^{k-1}\binom{n}{i}R^i(1-R)^{i-1};$

Then, the system prior moment is:

$$E(R_s) = 1 - \sum_{i=0}^{k}\binom{n}{i}\sum_{j=1}^{n-1}[\binom{n-i}{j}(-1)^j E(R^{i+j})].$$

Especially when execute probability among of each subsystem in the system for risk affairs is not independent, the distribution function of the of risk become change, some sub-systems resulted in serious damage because of risk or disaster, express that function is out of order, will bring the average risk of each sub-system enlargement in the system, the probability of risk loss of the related sub-system will increase, therefore, in probability theory it is described by "Pure death model" [35]. We can also discover from the above-mentioned discussion, the process of risk transmission has systematic complexity and when the boundary and deliver route of system are very vague, we are commonly study it by the spread model, so the risk transmission can be seen as an especial example of risk spread.

## 7.5 The Model of Risk Spread

There are so many studies on the model of system spread or risk spread movement currently. And the much more considerations of risk spread are no line system. As Qian Xuesen said, there is no preface on the macro view, and there is preface in the micro views, that are the important characteristics of the no-liner system. For example, the influence of the sunspot activity's distribution regulation, usually producing periodically large-scale agricultural natural disaster, the distribution of drought and flood is not evenness and add the influence of the environmental artificial break, possibility of occurrence of the disaster loss is difficult to measure, the risk delivers route is not clear. This disaster how actually to influence industry production, market and social economy life of people is difficult in quotation which makes deep influence how the big scope of economic development is. In the process of considering risk spread, we can make use of the concept of risk system to regard the relevant risk factor of investigation as complicated hierarchical structure, dynamic spatial-temporal systems.

### 7.5.1 Definition of Risk System Spread

Foreign scholars have made a great deal of research for problems of spread ability and evolving since the 90's in 20 centuries. The spread circumstance of two kinds of typical models is shown below in Figure 7.6.

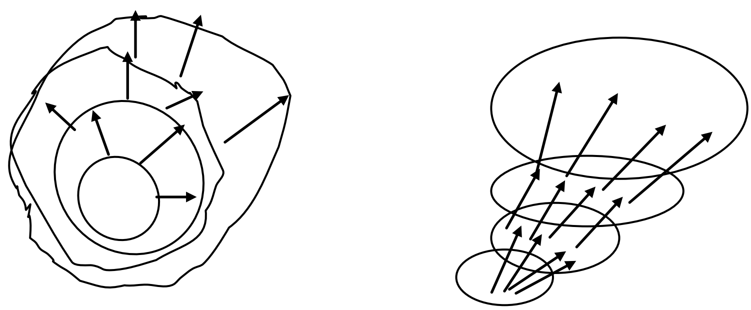

***Figure 7.6*** *Two Kinds of Typical Spreading Models.*

El Jai and Kassara (1994) studied and defined above-mentioned system spread concept [92]. If a dynamic system (S) can be defined as $\Omega \in R^n$, $(n = 1, 2\ or\ 3)$, $z(x,t) = z(x,t,t_0,z_0), t \ge t_0, x \in \Omega$ is a state of system, among $t_0$ is an initial time of the system and makes $z_0(x) = z(x,t_0)$, assume its behave as following characteristic of evolution:

$$z(x,t,t_0,z_0) = z(x,t,s,z(\cdot,s,t_0,z_0)), t_0 \le s \le t.$$

Let $\omega_t$ as a point set concerning for all $x \in \Omega$, this represents in the time t, the z(x, t) satisfied with a given characteristic $\mathrm{P}$, which makes:

$$\omega_t = \omega_t(t_0, z_0; \mathrm{P}) = \{x \in \Omega | \mathrm{P}z(x,t,t_0,z_0)\}.$$

Suppose for the utility (u) that we study in the risk system, according to the relevant definition of this system (S), utility satisfies to this definition giving out the characteristic P and sub-domain of $\omega_t$. Hence we suppose:

(i) On the level $I=[t_0,T](T>t_0)$ in time, if from $\omega_{t0}$ the beginning, set group $(\omega_t)_{t\in I}$ is increased, in a certain significance $\omega_s\subset\omega_t, 0\le s\le t\le T$. Then the system(S) is called P-spreadable.

(ii) If a set group $(\omega_t)_{t\in I}$ is decreased, the system(S) then is called P-absorbable.

(iii) In special cases, it is characterized by u (x, t) = 0, then the system (S) is called no (or null) spreading significance.

By means of this utility spread definition, we can use it to analysis of risk spread in management system. As we already discussed in risk utility theory of Chapter 2, our analysis for risk system should be possible directly use this concept or theoretical methods as the study basis.

### 7.5.2 Build up of Risk Spread Model

Establish the spread characteristic of P in system to satisfy the utility function $u(x,t)=e^{B(x,t)}$, Make $\Omega=[0,a]$, there is big enough for a>0, can make the system(S) carry on a description with differential equation. Hence:

$$\frac{\partial u}{\partial t}(x,t)=B'e^{B(x,t)}=b(x,t)u(x,t),\exists B'=b(x,t),\forall 0<x<a.$$

And have, $u(x,0)=u_0(x)=\begin{cases}0 & 0<x\le 1\\ e^{\frac{1}{1-x}} & x\ge 1.\end{cases}$

and $b(x,t)=\begin{cases}0 & 0\le\dfrac{x}{1+t}\le 1\\ -\dfrac{x}{(1+t-x)^2} & \dfrac{x}{1+t}>1.\end{cases}$

When t>0, for $x\in\Omega$, the solution of the model is as bellow:

$$u(x,t)=\begin{cases} 0 & 0\le \dfrac{x}{1+t}\le 1, \\ e^{\left(\frac{1+t}{1+t-x}\right)} & \dfrac{x}{1+t}>1. \end{cases}$$

Under the circumstance of zero spread for the system, we have $\omega_0=[0,1], \omega_t=[0,1+t]$. Obviously the system spread is from the beginning of $\omega_0$.

When considering risk spread increases doubling with time, in the same system will appear displacement as follows:

$$b_1(x,t)=\begin{cases} 0 & 1\le \dfrac{x+1}{1+t}\le 2, \\ -\dfrac{x+1}{(1+2t-x)^2} & \dfrac{x+1}{1+t}>2. \end{cases}$$

For $x\in\Omega$, when t>0, the solution of the model is given by formula:

$$u(x,t)=\begin{cases} 0 & 1\le \dfrac{x}{1+t}\le 2, \\ e^{\left(\frac{1+t}{1+2t-x}\right)} & \dfrac{x}{1+t}>2. \end{cases}$$

Because the dimensional number of system sub-domain $\omega_t$ is increasing at this time. $\omega_t=[t,2t+1], \forall t\le(a-1)/2,$ so the system is no longer a zero-spread. It indicated that utility u(x, t) of system become no-liner variation with the time and sub-domain.

### 7.5.3 Multi Dimensional Stochastic Spread Model

The theories of classical stochastic process once gave the definition of multi dimensional spread process. Combine with the forward and the backward equations of Kolmogorov described the n dimensional spread regularity of random affairs [34] [90].

Assume the n dimensions of random vector process $X(t)\underline{\Delta}(X_1(t), X_2(t), \cdots, X_n(t)), t \geq 0$ is the process of Markov. Its state space is the n dimensional Euclidean space $R^n$. The distribute function of transfer probability is F (s, x; t, y). Suppose the process to be located on x in the time t, for [t, t+Δ t] considering the variation of X (t, t+Δ t)-X(t), when Δ t very small, X(t, t+Δt)-X(t) be also very small. Then all the transmitting probability distributes function is:

$$F(t, x; t+\Delta t, y)\underline{\Delta}F(t, x_1, ..., x_n; t+\Delta t, y_1, ..., y_n)$$
$$= P(X_i(t+\Delta t) \leq y_i, i = 1,2,...,n | X_i(t) = x_i, i = 1,2,...,n).$$

Here $x = (x_1, x_2, ..., x_n), y = (y_1, y_2, ..., y_n) \in R^n.$

Take $S_\delta$ meaning x as the center of a circle with radius $\delta > 0, \Delta t > 0$, then the process continuous condition is: $\lim\limits_{\Delta t \to 0} \int_{R^n \setminus S_\delta} d_y F(t, x; t+\Delta t, y) = 0.$

Hence, to satisfy the drift (offset move) coefficient $a_j(t, x)$ of Markov multi dimensional spread process, that is called as infinitesimal of expected displacement, and the spreading coefficient $b_{ij}(t, x)$ that is also call an infinitesimal variance, both can be represented respectively for:

$$a_j(t, x) = \lim_{\Delta t \to 0} \frac{1}{\Delta t} \int_{R^n} (y_j - x_j) d_y F(t, x; t+\Delta t, y)$$
$$= \lim_{\Delta t \to 0} \frac{1}{\Delta t} E[X_j(t+\Delta t) - X_j(t) | X(t) = x], \qquad j = 1,2, \cdots n;$$

$$b_{ij}(t, x) = \lim_{\Delta t \to 0} \frac{1}{\Delta t} \int_{R^n} (y_i - x_i)(y_j - x_j) d_y F(t, x; t+\Delta t, y)$$
$$= \lim_{\Delta t \to 0} \frac{1}{\Delta t} E\{[(X_i(t+\Delta t) - X_i(t)][(X_j(t+\Delta t) - X_j(t)] | X(t) = x]\}, \qquad ij = 1,2, \cdots n.$$

Here, $B(t,x)=(b_{ij}(t,x))_{n\times n}$ positive definite.

If, $X(t)\underline{\Delta}(X_1(t),X_2(t),\mathrm{L},X_n(t)),t\geq 0$ is to spread process, $\frac{\partial F}{\partial x_i}$ and $\frac{\partial^2 F}{\partial x_i x_j}$ exist and continuous. Suppose the n dimensions transfer density function P(s, x; t, y) existence, then we can build up the Kolmogorov forward equation of the n dimensions spread process: [34]

$$\frac{\partial p}{\partial t}=-\sum_{i=1}^{n}\frac{\partial[a_i(t,y)p]}{\partial y_i}+\frac{1}{2}\sum_{i,j=1}^{n}\frac{\partial^2[b_{ij}(t,y)p]}{\partial y_i\partial y_j}.$$

The Kolmogorov forward equation:

$$\frac{\partial F}{\partial s}=-\sum_{i=1}^{n}a_i(s,x)\frac{\partial F}{\partial x_i}-\frac{1}{2}\sum_{i,j}^{n}b_{ij}(s,x)\frac{\partial^2 F}{\partial x_i\partial x_j}.$$

If the space of stochastic spreading process is homogeneous, when drift coefficient $a_j(t,x)$ =0, spread coefficient $b_{ij}(t,x)$ =2 D, if the initial distribute P{X(0)=0}=1, then random spread process be the famous Wiener-Einstein process. It originally to study is the heat conduct equation to express the concentration of matter diffusion in the system. If we replace to depend on the calories function which changes to measure with space in time with the utility function, study risk spread in the risk system, define this utility function as [118]:

$$U=U(x,t)=E\left\{\int_0^T u(X_t,t)dt\right\}.$$

So that, the risk can also be shown as a Wiener-Einstein process to spread in the system, which all probability density transfer process can be decided by the utility of the spread equation:

$$\frac{\partial U}{\partial t}=D\frac{\partial^2 U}{\partial x^2},U=U(x,t).$$

It can be proved, when the mean value is x, and variance is $2D_t$, which all probability density of the process is: [34]

$$p(x;t,y)=\frac{1}{\sqrt{2\pi\cdot 2Dt}}\exp\left\{-\frac{(y-x)^2}{2\cdot 2Dt}\right\}.$$

And its normal distribution characteristic function is: $\varphi(x;t,\theta)=e^{(ix-D\theta t)\theta}$.

### 7.5.4 Lead to Chaos of Risk Spread

Speak of the risk spread has to lead to the thorough research of the phenomenon at last, the professor Myron S. Sholes who acquired the Nobel prize of economics in 1997 once said [18], The risk governor can manage risk effectively only when they well grasp chaos theories. The study of chaos theories are how to find out the salient event for decision maker from the numerous complicated and giant miscellaneous information, look for a preface from no preface, by analyzing obvious affairs, thus attain an expectation target, and work out the actual problems.

From the understanding process for a few kinds' movement regularity of the risk system, the ultimate value fractal theories can be embodied at last. Among them, the dimensional problem of the concerning system is very important in the discussion of the system hierarchical structure. The measurement problem, when we measure the true degree of the system movement is a clear spot in the agricultural production and management. For example, the risk of the loss of food production for single producer, the loss of 10 and 100 kilograms is very important, thus in a region it can be account with 100 kilotons, the distribution of production loss may be dispersion, and also likely to be concentrated. So this utility function or risk distribute function is very difficult to express with a liner function, the characteristic of a system dynamic state, the no-liner, not-continuous to express. Therefore, the complicated and giant system research should begin from micro view, because the micro view is orderly, should commence from the research of the small mold. Thus modern management has become accurate precise management.

There are so many theories, definition and explanation with the chaos, what to reflect is mainly a special property of some no-liner motive system, such as "some stochastic processes of certainty system, regardless the beginning condition make however small change, may make the solution long-term feature having obvious difference [94]. The chaos property of system namely the solution has impressionable dependence to the initial value". The first prototype of chaos research is a Lorenz system; the Lorenz (1963) once studied to heat from the underneath of parallel plank midstream the two-dimensional convection. The Moon and Holmes (1979) studied for the vertical magnetic field vibration force model, found the Duffing equation, which got a chaos solution in scope of certain parameter values [95].

Concerning the chaos research, the author still wants to talk a little superficial understanding. The research of chaos theories not only is for the sake of "go to thick take accuracy," but also is decided by our viewpoint to the problem and it wants to attain the accuracy request. If put chaos problem, then complicated and giant system research together we can discover this. For example, Newton's mechanics studied matter movement of the n dimensions space and only using Euclidean geometry (the interior angle of triangle equal to 180°) that can immediately explain its mechanics system of his built up. But Einstein's relativity theories need to use non-Euclidean geometry to explain science. There are two kinds of non-Euclidean geometry, one is treated infinite astrospace by the inside and the other parts of space, first, N. I. Lobachevski (1793-1856) put forward "geometry of N. I. Lobachevski", he set out from the negate the "fifth parallelism postulate", as a result lead to conclusion of triangle interior angle and less than 180°, but successfully reveal the phenomenon of red shift and time space bent in the cosmos; "B. Riemann (1827-1866) geometry", then from outside and ground research how to measure our star, got extensively applied in the theory of relativity, remote sensing and earth digraph, as a result got the conclusion of a triangle interior angle with more than $180^{\circ}$[96]. If we study the opening complicated giant system have to cross over these three time space ideas in cosmoses, establish model of mathematics in the structure, hierarchy and the main factors connection in system, mathematics is diverse, but there is only one giant system. When risk spread system we studied become more complicated, it not only has much more current dimension (non-integral dimension), nonlinear, but also has the fine structure again and the statistics self alike form, describe this system can use the fractal dimensional theories. If it is to cross over a time space, whether want to be study by the theories of “fractal form or dimension”. Adopt what analysis method should be decided by problem-solving actual demand.

## Summary

This chapter put the management risk of the agriculture production into an opening complicated and giant system place to carry on the discussion of the system. At first, to compare the basic differentiation between the concept of risk system and the “system risk” concept, which already has elaborated necessity and meaning to establish the system concept in the two aspects of theories and fulfillment, defined the global risk system and agricultural production management risk system.

Secondly, from the idea of the whole system, hierarchical structure, connection, dynamic state complexity and the system purpose, put forward to make risk system of agriculture management become the sub-system of global risk, think that the risk system of agriculture production management equally has a liberal complicated and giant system characteristic, should enhance to identify, supervision and research for the agriculture risk, convenient to establish the decision system of the macroscopic management of the agriculture risk in China to resolve the regret which China is short of carrying on macroscopic risk management's study for the big agriculture.

The third, the risk system is opening, connection complicated, its boundary sometimes is even not clear. For the realistic system, an opening complex giant system to deal with risks has four main characteristics at least, the first is that the risk distribution in the system usually has hierarchies. The second is that actual and latent risk factor to remit gather may make system occurrence of the risk. The third is that a risk sometimes can carry on deliver along the particular route in the system. Four is that when risk transmitting routes are not clear, the main preface factors in risk system are not clear; the risk can change with time and carry on spread on the different system scope, different system hierarchy. These can be summarized four main regulations of the risk system movement. Any complicated circumstances that these regulations took place all may make the system get into appearance of confusion and only use the no line, mutation, divide form, cent dimension and draw up period bifurcation etc, to make explanation, this also well proved the system complicated characteristic that risk movement has. The fourth, according to risk system as the characteristics of opening complicated and giant system to express, we have carried on system description and discussion with the model method. The summary is given below.

(i) We give a definition of the system to built up the risk hierarchy distribution model. Adopt a structure tree to describe the hierarchy of the risk distribution, with the function of the entropy (risk degree) measures system distribute of the risk structure and studied problems of the fractal and the fractal dimensional of the risk distribute in the meantime.

(ii) Using mutation model to describe the risks gather regularity, particularly on the characteristics of cusp mutation model, the control variables have

2 dimensional and the state variable has 1 dimensional, which are much valuable in practical application.

(iii) Studied the risk transmission model, especially establish the series and parallel model of risk system. When the risk system is many, the string merge complicated inter-texture process can pass system ratings a processing merger for the establishment of limited dimension model. When all the risk system needs to distribute together, or though is together distribute can use a logarithms expression, the log normal distribution for gain's distribution will also express a risk to deliver not line and divide a form characteristic along with the increment (system hierarchical increment) of the system complexity.

(iv) On the problem of risk spread, the cognition of non-linearity complicated system that Qian Xuesen concerning “the macro view contain preface, the micro view has no preface” deeply is embodied. For this purpose, this text use the definition of reference system spread which put forward by Jai and Kassara, and make use of the utility function to establish risk spread model. Especially when describe to discover many dimensions random spread model that, when spread space become together in time, given settle to be partial and move parameter for 0, spread parameter is 2D, risk spread can also see into a Wiener-Einstein process. On the research, we discovered and defined differentiation of risk transmission and the risk spread, we think, risk transmission is an especial example of risk spread. And through research of any risk system regulation can lead to appear chaos phenomenon, and spread of the risk lead to chaos is also inevitable at last.