

On Methodologies of Socio-economic-eco Complex System

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(May, 2000)

ABSTRACT

Socio-economic-eco complex system includes two sides of static and dynamic states, which makes it difficult to understand and solve. With this fact, we suppose that comprehensive & dynamic methodology and model sets can be introduced into the problems of large complicated scio-economic-eco system, which is a way of combining qualitative & quantitative analysis.

- Complexity of Socio-Economy ecosystem

1. The complex characteristics & Behaviors modes of Socio-economic-ecosystem

Socio-economic-eco complex system has strong counter-intuitiveness, insensitivity to the variation of the parameters in the system, indomitable resistance to the change of the policies, irreconcilable discrepancy between the long-term interest and short-term interest&

between the whole and the parts and the inclination of low benefit. So its behavior modes can be very complicated, for example, kinds of oscillations based on increase and decrease with different cycles, even under the determination, bifurcation, chaos and Catastrophe can happen.

2. The contributing factor of the complex behaviors & characteristics modes lies in the internal complexity of the system.

The complexity includes two sides of static and dynamic states.

- 1) On the static state, this kind of system has high-nonlinearity, high order, large scale, multi-level and multi-loop feedback. Furthermore, this system is composed of two high-nonlinear parts---substructure and parameter between which there is multiplied, overlapping, complicated information feedback among different levels, departments, and even regions. The following table^[2] might show you a general description of the complexity of the static state. In fact, the real system is more complicated than it.

Scale	order	equation	Example
Large	>75	>1500	SDNM of the U.S., 200 orders, number of equation over 4000 at beginning, being reduced to about 2500 in 1993.
Middle	20-70	500-1500	Key model of Chinese S.D. national model series, 50 orders, number of equation about 1000.
Small	<20	<500	Typical simplified city model & enterprise management model, etc.

- 2) On the dynamic state, generally, these feedback relations include all kinds of delay, amplification or attenuation, and non-linear link. These complex non-linear feedback relations and parameters are dynamically changing with the time, so are some important

non-linear parameters. Thus it forms the dynamic complexity. Inside the system, the dominant part and dominant feedback loop are continually transferring and changing and their polarity is also changing. That is the static and dynamic complexity of structure and parameters in the system.

Another, We suppose that we should at least use middle-term (40-50 years' span) model to study the short economic cycle in our country, the Western business cycle and Kuznez cycle. For urban and regional development strategy and planning, it should have long-term (about 1 hundred years' span) or even ultra-long-term (several hundred years' span) model to study its long-term restricting and driving factors. As for national and world socio-economic long-term development strategy and planning, involving such as the Western economic long wave, population, natural resource, energy, ecological environment, change of social culture and thought and its effect, etc., only the ultra-long-term model can be qualified.

(Comment: how can people understand the dynamic behavior and dynamics of these complicated systems only by their mental model or qualitative model?!)

Therefore, under the common affection and impetus of internal & external forces, because of the complexity of internal structure and parameters, a complex system may produce virtuous or vicious cycles and results and show the relatively complex, even strange characteristics and behavior modes. The above description about the internal structure, parameters, characteristics and behavior modes can be put in a nutshell--the **Dynamics** issues of the complex system.

3. It's difficult to understand and solve the problems and issues of a large complex system.

A methodology solo can't help us solve these problems and issues with satisfaction. The author believes that as an effective way, under the framework of the theory and method of SD, we can apply comprehensively all kinds of theories and methods such as: economic mathematics, econometrics, economic-cybernetics, optimization theory, non-linear system theory, large-scale system theory and other systems theories with economic theory & management theory, by which we can analyze and study the problems in the economic and managerial systems and identify the way to solve them.

- . Methodologies of Research

We suppose that the effective method to analyze the dynamic characteristics of complex system is nothing but a comprehensive methodology and model sets that combine synthesis

with systems analysis, inductive inference and deductive one. As for qualitative and quantitative analyses, it should be "qualitative--quantitative--qualitative", a spirally ascending and deepening process of cognition, based on the qualitative analysis as a precursor and the quantitative analysis as a necessary support. Until the judgement of the results of the both analyses is at a relatively satisfactory degree or accuracy, this process will

not reach its end. However, it's impossible to obtain a perfect & final result.

- . Understanding and Solution of the Problem of the Dynamics of a Complex System

The only way to gain step by step a relatively reliable & trusty result is to use the method mentioned above. By qualitative method alone, we can't understand the dynamic process and solve the problems inside the complex system, even the mental model of the group is also inaccessible. Obviously, only by human mental model it's impossible to solve this dynamic problems and also impossible to analyze and solve these problems solo based on so-called "Qualitative System Dynamics".

- The integration of qualitative and quantitative analyses of SD

As an important methodology analyzing problems of complex system, SD involves itself two indivisible parts—quality and quantity. It can be comprehended clearly from the steps of SD modeling. Neither can "Quantitative System Dynamics" exist and work, nor can "Qualitative System Dynamics". Only the original definition that SD is the integration of qualitative and quantitative analyses is significant and valuable.

V. Conclusion

Comprehensive & dynamic analyses is an approach to study a complex system, which is a way of combining qualitative & quantitative analysis, taking SD & systems thinking as its core, using SD model as its main framework & absorbing the quintessence of other qualitative & quantitative theories & methodologies. It can be used in studying the problems of a large complicated scio-economic-eco system.

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