COMPREHENSIVE METHODS OF SYSTEM ANALYSIS, INFERENCE , SYNTHESIS AND MODEL SETS FOR STUDYING THE SOCIO - ECONOMIC - ECOSYSTEM

Professor Qifan Wang

School of Management,Fudan University,
Shanghai, 200433,People's Republic of China

ABSTRACT

The author explores a comprehensive methods of systems analysis, inference and synthesis and model sets for studying complex system. These methodologies and model sets can be used in studying the development strategy and planning of socio-economic-ecosystem. It has be successful in the study of Pudong New Economic Zone of Shanghai.

INTRODUCTION

1. The Characteristics of a Complex System

Since the socio-economic-tech-ecosystem is a high-nonlinearity, high order, large scale, multi level and multi-loop feedback complicated system, it is impossible to use traditional methodology or linear analysis to deal with a complicated system, nor can it be settled effectively by only a simple new theory and method of systems science.

2. Theory and Methodology

Based on the wide study of theories and applications in 1980's the author synthetically applies economic theory, management science, economic mathematics and system dynamics, and draws the equintessence of other theories of systems science, to put forward these methodologies and model sets. These are comprehensive theories, methods and means, which include the combination of qualitative and quantitative analyses, systems thinking, synthesis and inference, system forecasting, planning and optimization, etc. (may be intellectual), ard also can use to research non-linear and complex time-change large system. In shorthly, that is a combination of qualitative and quantitative, system thinking, synthesis, inference methods and means.

DESCRIPTION OF THE THEORY AND METHODOLOGY OF THE APPROACH

1. The Theoretical Foundation of the Approach

(1) Methodology

Its methodology is system methodology which put the research object in system form, and insist on the view of systemetic, dialectical, developmental and historical materialist.

(2) Basic Theory

It is based on economic theory, management theory, economic mathematics, system dynamics, non-linear system theory, large-scale system theory and system theory which is being formed.

(3) Applied Technics

It uses computer sciences, simulation, the science and technic relative to the research object.

2. Description of a System

(1) We basicly use the high-order non-linear random partial differential equations, which are a set of evolutional equations with time-space structure, for the part which can be quantified among real system. Because of the difficulty in using mathematic and simulation language, we simplify those equations into deterministic differential equations in model-setting, and use the noise-function to describe the effects of uncertainty random facters in real system.

(2) We apply partial quantitative, partial qualitative or qualitative method to deal with non virtuous-structure which can not be describled by differential equations and other mathematical functions in modeling. We use approximately virtuous structure in stead of bad-structure making bad-structure to be changed into relative virtuous-structure, or combine qualitative and quantitative methods to quantified some parts of qualitative problems. We use qualitative method to deal with some parts of un-quantitative and un-partial-quantified problems.

3. The Composition of the Approach

Thought, method and frame of "systemetic method, comprehensive model sets " has been proposed in introduction, and the same time the approach also includes a series of "hardware". After it has been set, it is a synthetical system which contains model base, data base, and man-machine interface, etc. The appoach can be classified two categories by the research object -- macro and micro, but it has the same thinking, method and frame. As following, we simply introduce model base which we have put greater efforts and have many results.

(1) Comprehensive Model Base with Multi-Models

(a) Various common used quantitative models such as econometric model, system dynamic model, industrial correlation analysis model, dynamic input-output model, time series model, economic control theory model, etc.

(b) Combination model of econometrics, mathematic economics and system dynamics.

(c) Integrated model with combination of industrial correlation analysis, dynamic input-output and system dynamics.

(d) Combination model of non-equilibrium self-organized theory and system dynamics.

(e) Coordinative use of optimization theory model and some of above-mentioned models.

(2) Technique One of Simplifying Modeling

For a research object, to set up a key model with some sub-models and combine to use those models according to the needs of research. This is a good, saving and quick technical way, according to several decades international experiences and our one decade practices, as well as combining our national conditions in modeling.

(3) Technique Two of Simplifying Modeling

To set up generic substructure (about 10) for some kinds of system, then, according to requirements of modeling, to assemble and form a suitable models. This technic can be used with (2).

(4) Classifying Models According to Order and Number of Equation

Table 1

scale	order	equation	examples
large	>75	>1500	SDNM of the U.S., 200 orders, number eqution over 4000.
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 city model, enterprise management model, etc.

Models can be classified into three kinds -- large, middle and small by orders and number of equations. As shown in table (1), it should be selected by purpose and requirement of modeling.

(5) Classifying Models According to Span of Operating Time

Table 2

time span		years	examples	main suitable model
short-term	ultra short	T<1	quartly and yearly forecast	ecomometrics,time series,input -output etc.
	short	1<T<5	short term forecast and plan	the same as above
middle-term		5<T<20	national urban and regional long term forecast and plan	econometrics (<10yrs) dynamic input-output system dynamic & its combination
long-term	long	20<T<50	national,city region long- term forecast and plan	mainly use system dynamics and draw other method to form an inte- grated model
	ultra long	T>50	to study the Western econ- omic longwave ecological environment, population, natural re- sources, social culture and thoughts,etc	the same as above

We found outhow to select a reasonable running time span of a model for a specific purpose and problem is still a confusion for many decision maker in our country. According to the feature and dynamic mechanism and behavior of socio-economic system, we proposed three modeling time spans -- short-term, middle-term and long-term as shown in table 2. Of course, the classification is rough and not quite accurate, and has proper overlapping each other.

We hold that we should at least use middle-term model to

study economic cycle in our country and Western business cycle, kuznez cycle, as well as city and regional developing strategy and plan. For urban and regional development strategy and plan, it should have long-term, or even ultra-long-term model to study its long-term restricting and driving factors. As for national and world socio- economic development long-term development strategy and plan, involving such as the Western economic long wave, population, natural resource, energy, ecological environment, change of social culture and thought and its effects, etc., only the ultra-long-term model can be qualified.

We also hold that , for improving decision, it is indispensable to establish a series of coordinate short-term, middle-term and long-term models for a nation,a region and a large city, and further to set up an approach of "systemetic method, comprehensive model sets" as this paper introduced.

4. The Main Functions of the Approach

(1) It can be used to forecast and plan in short-term, middle-term and long-term for several kinds of socio-economic system, and to systemetically and synthetically study middle-term and long-term development strategies.

(2) It can be used to synthetically study complicated, high order and multi-department large system in macro- and micro-level.

(3) The approach owns well-open and adaptability itself. It is convenience to use various data,information, experiences and knowledge, and also to draw and merge the equintessence of other disciplines and science theories, making the approach itself to be improved and consummated unceasingly.

(4) The approach can be used as a tool to develop the combination effects and creativity among decision maker, experts and modeling personnel, making the organization and system (from nation to enterprise) managed by decision maker to quickly become a learning organization possessed well dynamic structure, self-study, self-adjustment, strong adaptability and full of energy.

(5) The relative errors of quantitative analyses of Shanghai Pudong development from different mothods are less than 5-10%, after using the approach.

SOME TECHNICAL PROBLEMS ABOUT MODELING AND THE APPROACH ESTABLISHMENT

For these issues, such as definition of system boundary, description of system. treatment of endogenous and exogenous varialbes, estimation of parameter, sieving and technical treating of data, test of model, etc., the author does not mention verbosely, since it belongs to bssic knowledge of space and time. Please refer to the reference.

PROSPECTS OF PNEA IN 2000
-- An Example of the Application of the Approach

This paragraph studies the blueprint of Pudong New Economic Area(PNEA) of Shanghai in 2000 by means of our approach .The development of Shanghai are influenced by its main factors such as transportation ,population and technology etc.Under different conditions, this paper puts forward two different development strategies. PNEA should plays a great role in rebuiding Shanghai's economic functions.

1.Background

With no exceptions that the development of the cities all experience the birth,growth,culmination and the decline.Shanghai is now just on the track of this regulation its further development. It's of crucial importance to study the development demand.

The development of PNEA or the East Shanghai New Economic Zone will be not only an important part for Shanghai's economic growth,but also a great event for China's modernization. The background of the development of PDNA can be viewed from
various aspects as follows.

First,as the largest industrial and commercial center of China and the major contributor to the national revenue,Shanghai has played a decisive role in China's economy over the last four decades.Shanghai itself has also developed an industrial system which is comprehensive ,integrated and of a relatively high technology by nature.However,it appears that some problems have occurred in recent years which have unfortunately hampered Shanghai's continuous economic progress.

(1).Its tertiary industry has sustained a slow growth rate,making its urban function imperfect.Shanghai is still an industrial city,but,as is widely recognized,it should become an economic,trade and financial center of China and even one of Southeast Asia.

(2).The superiority of leading industries in Shanghai is declining.The competitiveness of Shanghai's products is weakening in both the domestic and international

markets,which caused substantial drop of sales and trade benefit.

(3).The provisions of raw mateial and energy for industries in Shanghai were not regular.Her share both in the domestic market and in the export trade was declining in recect years.

Now the question are raised in the light of background analysis:
(1).What kind of development strategy shall we adopt?
(2).What kind of structure shall PNEA have?
(3).What is the GNP growth rate to be proprietely assigned?
(4).What is the proper population size for the PNEA?
(5).What the maximum capacity of transportation & communication should be for the development.

2.Modeling Conceptualization

Our approach is used in the following analyses:
(1).The macro relationship among the flows of manpower,raw materials,funds,information,technology and ecosystem of the whole system.
(2).The dynamic analysis of the coordination and equilibrium between the east and west regions of Shanghai incorporated in the sysyem .
(3).The dynamic analysis of the adjustment of industry structure and investment structure.
(4).The dynamic analysis of endogenous and exogenous factors that limit the generation and development of the system.
(5).The dynamic analysis of the development and modification of the western and eastern parts of the system as well as their influence and effects on domestic socio-economic development.

The models are developed according to industrial structure and inter-industrial relations:
(1).Classification and definition of various industries and their inter-relationship will be presented in terms of correlation coefficients ,the later will be obtained both from experiences gained by other countries or it can be produced by Delphi method.
(2).Spacially ,it can be devided into two parts that have interactions and inter-flows.

3.Model Framework

To study the PNEA, we created our model made of two parts ,the estern part and western parts.The basic structures of these two areas are similar .From this model,we analyze the transportation ,capital distribution ratio,the flows of population of future of Shanghai.The basic structure of each

part includes industries,population,GNP,transportation and technology.

Here are some basic assumptions:(for plan I)
(1).The initial simulation time begins in 1988.All the price indexes are based on 1988.
(2).The immediate consumption coefficients are constant.
(3).The population influx of Shanghai is 2 million.
(4).The total fixed capital of 2000 is 52.85 billion yuan.
(5).The productivity of 1990 is 8637 yuan per person which will be doubled every five years since 1990.

4. The Results of Base-run

The GNP of Shanghai is 65.55 billion in 1988 while 200 billion in 2000.The average growth rate during that period is 9.74% for plan I and 7.35% for plan II with 153.5 billion GNP in 2000.The GDP of PNEA in 2000 are detailed below:

Table 3. GNP in PDEA in 2000

Indexes	Absolute Value(E yuan)		Percentage	
	Plan I	Plan II	Plan I	Plan II
GNP in 2000	511.3	240	100	100
First Industry	6.5	3.0	1.3	1.4
Secondary Industry	248.5	130	48.	54.0
Tertiary Industry	256.3	107	50.1	44.6

5. Policy Recommendation

Based on the above simulation and policy tests ,we conclude:

(1).According to the current condition,the goal we set in 2000 will be achieved.
(2).The transportation capability is main factor limiting the development .It needs a great attention.
(3).Investment distribution ratio between industries and two areas are effective policy orientation that can adjust the industrial structure. We confess that it is difficult to have a breakthrough within a short-limited period. However, if we try to assimilate this obstacle in the development process itself,it will be encouraging.For example,the high demand for transportaiton resulted from the development of secondary industry may be overcome by emphasizing the development of tertiary industry.This will release the stress on the transportation capability. Furthermore,the tertiary industry calls for relatively few labor force which will be obtained locally.

(4). The population in Shanghai is a vital aspect for control. This potential crisis needs consideration for the decision makers.

Here we prospose:

(1).Increase the investment ratio in tertiary industry .Try to build Shanghai from a industrial city to a multifunctional central modern city.
(2).Solve the transportation problems to expediate the economic development.
(3).The coordinated development between the eastern and western parts should be adjusted.None of them can be prejudiced.

In all, the development of the western and the eastern parts should be coordinated and complemented from each other to ensure further development in Shanghai and realize its goal of an open, multifunctional and modern metropolis.

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