META-SYNTHESIS SYSTEM MODELING

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Abstract

The macroeconomic system is a complex system, so sometimes we need to study it from different perspectives with different resource of knowledge. Using Meta-synthesis System Approach (MSA) to construct the models for describing the macroeconomic system we design a flowchart for running the MSA, synchronous stage I (qualitative meta-synthesis)→Analysis stage (quantitative modeling)→synchronous stage II (meta-synthesis from qualitative to quantitative). When applying MSA, we always combine the knowledge from experts (including the intuition and experiences) and the results from different models.

Keywords: Meta-synthesis system approach, system modeling

1. Introduction

System modeling is a core activity used in describing and solving system problems. For different systems we may use different kind of models. Ackoff and Sasieni (1968) in their book titled in "Fundamentals of Operations Research" had mentioned five principles for constructing models: 1)modeling by knowing mechanism, 2)modeling by analogy, 3)modeling by data, 4)modeling by test and 5)modeling by artificial reality. About the basic theory of modeling Gu had introduced in the Chapter 10 of book edited by Li & Qian (1982). With the rapid development in solving the complex systems people find out that only a few of models is far to describe all the systems, then a set of models have been emerged for solving like energy, environment and economic systems (UN 1982, Kemeny & Snell 1972, Hafele & Basile 1979). Even more in recent years the model integration becomes more and more crucial. In our other paper we had introduced three approaches for integrating models (Tang, 2001). Since then modeling techniques have been developed a lot. For example modeling by rule now is widely used in multi-agent system, qualitative modeling used in social systems. Now we also can find the new trends to combine the system modeling with decision support emphasizing the environmental applications and other fields (Wierzbiciki, Makowski & Wessels, 2000, Makowski & Wierzbiciki, 2003). In this paper we will introduce the systems modeling by meta-synthesis system approach in solving the open giant complex systems problems (OCGS), especially emphasizing the macroeconomic system problems.

2. Meta-synthesis System Modeling

Macroeconomic system is an OCGS, we then use the meta-synthesis system approach (MSA) originated in 1990 by a Chinese scientist Qian, Xuesen to deal with OCGS problems (Qian, Yu & Dai 1993). Recently we are engaging in a major project supported by National Science Foundation of China. This project contributes to solve the macroeconomic system problems by using MSA. Since the macroeconomic system involves a lot of factors, attributes and aspects, so we have to deal with it from different aspects. In this project the members of different subprojects are now developing a series of different kinds of models. According to the modeling principles we may divide

them into several categories (Gu, et al., 2003):

Category I: Modeling by knowing mechanism, such as econometric models (Zhou, et al. 2003);

Category II: Modeling by analogy, such as case based reasoning (Zhou, et al. 2003);

Category III: Modeling by knowing rule, such as Agent-based modeling (Zhou, et al. 2003);

Category IV: Modeling by Data, such as Data mining model, neural network model (Tian, Guo & Lu 2003);

Category V: Modeling by evolution, such as evolutionary model (Di & Li 1998).

Since the macroeconomic system is so complex, it is necssary to study it from different aspects and use different resource of knowledge. When applying MSA to modeling the macroeconomic system we not only pay attention to the different categories of models, but also the cognitive aspect, so we design a flowchart for running the MSA, synchronous stage I (qualitative meta-synthesis) → Asynchronous or Analysis stage (quantitative modeling) → synchronous stage II (meta-synthesis from qualitative to quantitative) (Figure 1).

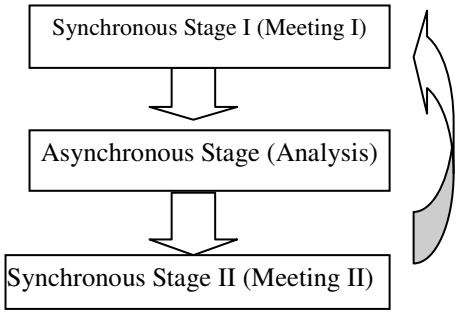

Figure 1. Meeting Process by MSA

In the first synchronous stage we pay much attention to identify the problems or issues. We will convene meeting to ask experts to discuss and express their own opinions. By using brainstorming we will collect the different opinions as much as possible, and then opinions will be converged into some assumptions and scenarios (see Figure 2). Before discussion, necessary data, information, knowledge and cases related to the problems to help experts to propose their opinions sound. In order to discuss deeply we will also use some tools, like ECB (Electronic Common Brain) designed by Xi'an Jiaotong University and GAE (Group argumentation Environment) designed by Institute of Systems Science and some conceptual models.

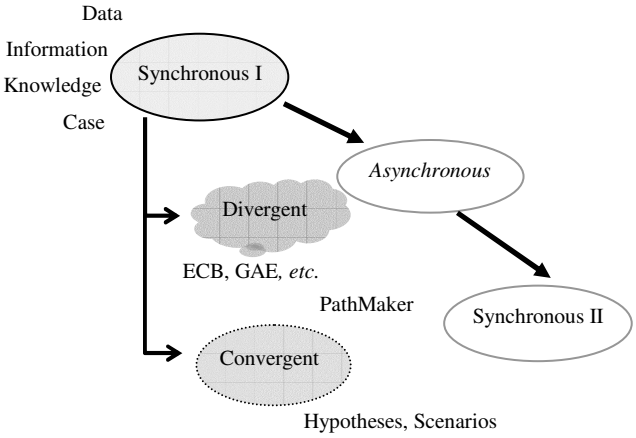

Figure 2. Synchronous stage I

Using these assumptions and scenarios we may move to the asynchronous stage (analysis) and construct a series of models: econometric models, system reconstruction model, neural network model, multi-agent model and evolutionary model etc. (see Figure 3)

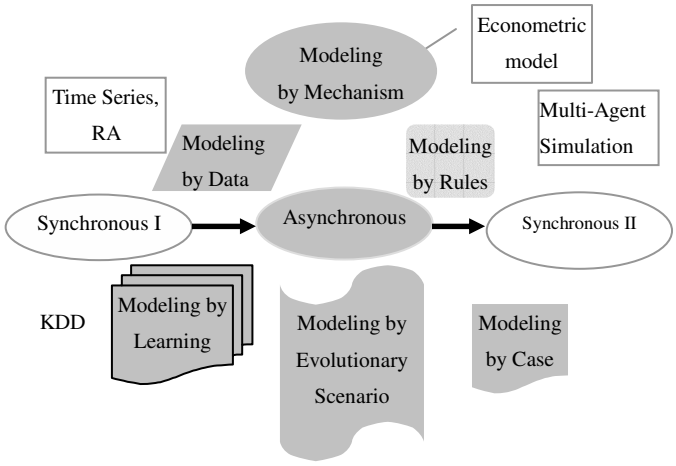

Figure3. Different models in the asynchronous stage

After running some model calculations we may move to the third stage-Synchronous stage 2. In this stage we will ask experts, managers and decision makers to attend meeting in order to check the validity of models. They may change the parameters, structures of models or ask some new models, even more change the assumptions and scenarios which they don't satisfy or just they are suspecting some conclusions (see Figure 4). All the process may be iterated till satisfaction by most of them. In order to get some consensus some useful tool for consensus building, such as voting, AHP, NG (Nominal Group), meta-synthesis system reconstruction analysis and possibly satisfying approach etc. will be applied.

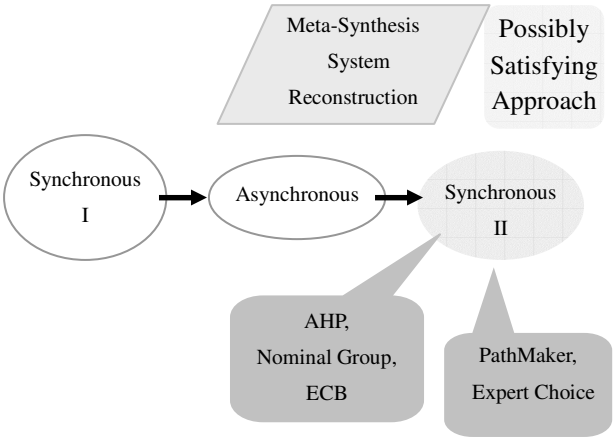

Figure 4. Synchronous stage II

In the MSA we always combine the knowledge from experts (including both intuition and experiences) and the results from different models. Since many members in this project have developed a lot of models belonging to different categories, or different models with the same categories but developed by different organization with different data and knowledge, so how can we use and integrate all these models is also the key problem for our research. Shanghai Jiaotong University has developed Agent technology to integrate models.

3. Test and Conclusions

In order to realize the whole system modeling process recently we had run some tests to verify our system modeling. In the September of 2003, a demo was shown in International Institute for Applied Systems Analysis (IIASA). The topic of demo is "how to evaluate China GDP growth with the impact of SARS by meta-synthesis approach". In this test we had collected a lot of different information from internet and other sources related to SARS and China economy. We had used the econometric models provided by Beijing Institute of Information and Control (BIIC) and neural network model by Tsinghua University. While organizing the meeting we applied PathMaker, which provides five components and eight tools. We have used some tools from this software and some tools designed by us. All the models can be stored in distributed network and run some models directly by our computer or using server through computer network. In using the econometric models we had run calculations under three assumptions on the economic situations and three scenarios on the SARS situations.

Due to time limits, we had not run more tests, and it is also a pity that more tools and models which have developed by the colleagues in our project had not been involved.

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