Macroeconomic Multifunction Equilibrium Growth Model of Wuhan

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Abstract

《Macroeconomic Multifunction Equilibrium Growth Model of Wuhan and its application》 is the first development application, it also the continuation of theory research and method research. This application model consists of 8486 parameters and 2689 equations. The results can be gained just one time by microcomputer. The sample period of the model is from 1978 to 1989. The prediction period of the model is from 1990 to 1995. They are both an entirety (whole).Its caculation results are output simultaneously.

This application research report is written in 200 thousands of Chinese words and consists of four parts: 1. Macroeconomic multifunction equilibrium growth model of Wuhan; 2. The lab of macroeconomic system of Wuhan; 3. The prediction policy-making report of "the Eighth Five-year planning" of Wuhan; 4. 607 kinds of indexes output from the model.

Because the paper length is limited by conference,only first part is translated into English. It mainly introduces the theory characteristics and structure of this application model, and the examination of the model as well as the new function of system software. The frame graph, flow graph and mathematic equation of the model are also introduced in theory and method research. Thus many places in this report are not detailedly discussed and are cited in the reference (1).

(Ⅰ)The theory background and auxiliary explanation of model-building

Wuhan macroeconomic multifunction equilibrium growth model is the first practical development application.

Multifunction equilibrium growth model is based on realistic causal relation. Realisty means that "equilibrium is the existing basis of the whole realistic substance. Quantitative change of homogenuous substance is practically existing in equilibrium. The equilibrium which loses homegeneity is qualitative change, or realistic equilibrium or homogenuous equilibrium"(1). This kind of equilibrium thought is different from traditional equilibrium theory. It is the theory basis of multifunction equilibrium growth model-building. Traditional equilibroum theory in economics issures from physics. In practice, it is an absolute equilibrium point, which is absolutely not existing or unrealistic in a complicated system. Nor is showed in the model. The model is not only a new

model but also a kind of new method, or formally, an organized combination of all kinds of methods in econometrics, planning theory, control theory, input/output analysis and system dynamics.

Input/output analysis is the result of econometrics and general equilibrium theory development. Input/output table shows the general law of a complicated system of social economy. As element period table shows element law, the importance of input/output table in social economy system is the same as that of element period table in chemistry. It is more and more realized by peoples.

So far, input/output table has been successfully and effectively used. In general, it is classified as two types: (1) After the complete consumption coefficient was discovered, the general quantity can be gained from the final quantity in equilibrium condition.(2) Combining linear planning with input/output table can provide a way to search for optimal method. But at present, the effective application of above two types of methods is only limited within static application. Like the dynamic input/output model, the Wuhan macroeconomic multifunction equilibrium model is the dynamic application of input/output table. But the structure function and effectivity of the model(which can be known from following introduction) excess greatly the limit of the traditional dynamic input/output model. As this application is initial development application and lack of experience, in addition, the data are not enough. It is far immature in deepth and width, and only the framework of application model was completed.

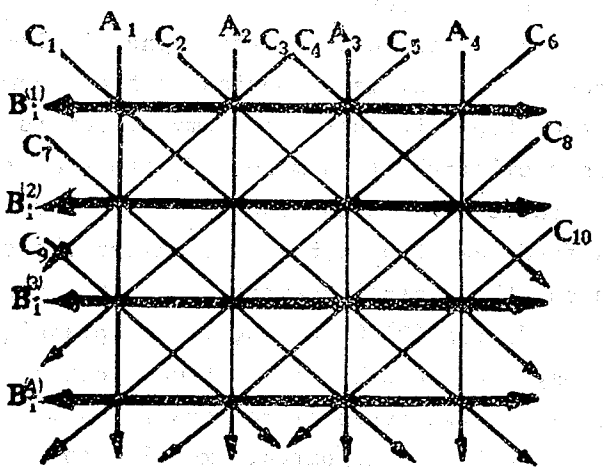
(Ⅱ)Structure of the model

This application model is classified according to material production department. It adopts eastern statistical accounting system. Because of the difficulty in collecting data, the departments classified in the model only include industry, agriculture, construction, transportation, post and telecommunication, as well as commerce. Industry is classified as metallurgy, electrical power, coal, oil, chemical, machinery, construction material, forest, food, texture, leather and sewing, stationery and other subjects, up to 17 departments.

As a whole, Wuhan regional macroeconomy is a macromodel. But "Macro" in the model is reflected by diverse industry department or "micro". One of characteristics of the model is the integration of "micro" and "macro".

The coordinaton of system element among industry departments results in the complicated structure of the model, or reciprical action of system elements in relative equilibrium is the foundation of existence, stablity and development of system. As to a regional economical system, the coordination of investment, construction, production, circulation, consumption, output, input of each industry department as well as the cooradination among industry departments is the

foundation of sustained, stable development of regional economy. The characteristics of the model structure will be briefly explained by following graph.



Each vertical line Ai (i stands for industry department, the following is the same) is an industry department classified in input/output table. For example, agriculture, metallurgy, machinery, chemical, texture and so on. The number of industry department classified in the model, or the number of line Ai depends on requirement and possibility of model-building. In this application model, i=17. As a production department, it always develops forward. Thus we use a single arrow to stand for it.

As every material production department, line Ai bunch constitutes industry structure, and forms general supply. The structure and operation way of line Ai are explained in the reference (1) The realistic production of any industry department must possess laborer. Labor material and labor object at any time. The integration of those three elements is the neccessary condition of the normal production of any society. We call it as production equilibrium. For example, only as for labor object, all middle products are neccesary condition of normal production of any society. The normal production of society requires not only the coordination of middle products or production equilibrium in any society, but also the final products of all societies. For example, we regard accumulation, consumption and input-output coordination as social production equilibrium. Therefore, production equilibrium is the neccessary condition of normal society production. Social production equilibrium is the full and neccessary condition of normal production of any society.

We use hoare horizontal line Bi(t) to stand for social production equilibrium. (t stands for time). Because social production equilibrium is a reciprocal supplying and satisfying procedure among indusrty departments and in the whole

society, we use double-arrow to stand for it. The gap between horizontal line or time t evaluation is generally confined to economical year. Thus the number of line Bi(t) depends on not only the classification of industry department but also the length of time t, including sample period and prediction period, in this application model, t=18 years. Sample period is 12 years, prediction period is 6 years.

In the model, line Bi(t) is the horizontal in input-output table, and consists of middle products, big repairment, productive and nonproductive fixed asset accumulation, flow asset accumulation, social and personal consumption and input-output. Therefore line Bi(t) bunch constitutes demand structure and forms general demand. The model program of line Bi(t) can be obtained from the reference (1).

After explaining line Bi(t), we emphase the followings: Social production equilibrium including production equilibrium is relative even if in normal condition. The relative equilibrium degree of a complicated social economy dynamic system depends on every element of contemporary social production. These elements include mainly development degree of science and technology, management degree, as well as production, circulation and consumption degree. Of course, How to check a normal social production procedure must be taken as a standard to check above elements. Nonnormality or hetergeneity is nonequilibrium. Without above principle, emphazing excessive stack and shortage is lack of systemetic convincing. Here, we must repeatedly explain: traditional equilibrium view in economics results from physics. In practice, it is an absolute equilibrium. This kind of absolute eqailibrium point is not existent in a complicated system. It is also nonrealistic and cannot be reflected in the model.

In normal society production, line Ai and line Bi(t) line bunch Ai and line bunch Bi(t) are the supply and demand of every industry department. Now that the equilibrium of general society supply and demand is relative, this kind of relativity is limited or called relative equilibrium degree. For example, shortage degree, slack degree and so on. Simultaneously these will be neccessarily reflected in the indexes such as net output, net input and reserve in final products. What variable adopted is fit depends on the detailed situation of every industry department. After the variables are determined, they will adjust the element of movement, change and development of every industry department and even the whole system in relative equilibroum. They are indicated in inclined thin line Ci in the graph. Line Ci results from the crosspoint between line Ai and line Bi(t). It regulates the movement change and development of every industry department and whole system in relative equilibrium. Thus like line Ai, line Ci has single direction. It is shown by single arrow.

In the model, line Ci is regulation line. According to the relative equilibrium degree of supply and demand of every industry department, it regulates the movement, change and development of every industry department in the emulation

procedure. The difference of this kind of adjustment from object control of the model is that it adopts close circulation feedback control, which is showed in the reference (1) about the installment and control style of control variable. The former is in the same emulation procedure. The latter is the emulation of a tautological system, which makes respective object to lie in permited error scope, or it convergences to expection object value.

The installment of line Ci variable depends on requirement of the model and the possibility of statistical materials supplied. For example, we use the hypothetical final reserve quantity of every industry department as regulation variables in system software experiment model (which is showed in the reference (1)). In this application model, because the statistical materials collected are limited. As requlation variables, the net output is net gap of the supply and demand of every industry department.

Precisely speaking, line Ai, line Bi(t) and Ci are the procedure in which line Ai bunch, line Bi(t) and line Ci bunch move, change and develop coordinatedly forward. They are also the procedure of sustained, stable and normal production of any society.

(Ⅲ)Sample period, prediction period and parameter estimation of the model.

One of the goals to establish model is to predict the future. Why the model can predict the future is that any thing movement has inertia. Inertia principle (also called coherence) is one of theory basis which use model to predict the future. This principle shows the importance of sample period to prediction period.

Nonlinar parameter estimation of prediction period of a complicated system is far more complicated and difficult than the similar parameter simulation of sample period. Through a large amount of examinating, surveying, comparing and analysing the parameter system of sample period, we discovered that the change law and change cycle of some parameter are directly relative to the change law and cycle of other parmeters in the system. Fox example, the output rate of productive fixed asset primitive value is directly relative to investment, stagnant and re-added fixed asset. The greater the re-added fixed asset change rate, the smaller the output rate of fixed asset primitive value in constant time. When it reduces to some degree, it begins to grow step by step again, and growth tendency is rather quick. Afterward, it enters into relatively stable period. That shows the reciprocal action of different parameters in the system has regularity. This kind of interrelation commonly exists in the complicated system of society and economy. Fox example, policy factor, technology and nature factor belong to this type. They are the main reason of system nonlinar. Thus it is not enough that the parameters of prediction period only imitate the similar

parameter of sample period. The reciprocal action rules among different parameters must be deeply researched and introduced into nonlinar parameter estimation. In order to introduce them, we think it is neccessary to make complete interrelated experiment and analysis about the whole structure of sample structure.

Rightly based on above consideration, We highly pay attention to whole sample period research of the model, especially, the structure research. Therefore, in this application model, We use the systemetic histry stastical materials of Wuhan macroeconomy, or 12 year sample which shows accurately system development and change from 1978 to 1989 as foundation. In the sample period, all parameters of the model come from statistic materials. In another word, after sample period is determined, a group of parameters in sample period are sole. Thus the output results in model emulating or all variables value in sample period are identical with practical statistic data.

The parameter estimation of six year (1990-1995) prediction period is based on practical statistic parameters. In this application model, three kinds of estimation methods are adopted in parameter estimating of prediction period.

The first is traditional quantitative estimation method. We use traditional linar method such as regression and smooth to estimate many parameters in the model prediction period, especially when their change tendency is rather obvious. For example depreciation rate, reimbursement rate and price index.

The second is the estimation method combining qualitative with quantitative method. We repeatedly made experiment and survey to some important and especially sensitive parameters such as output rate of fixed asset primitive value, and compared and analyzed the experiment results. Based on quantitative analysis, we made qualitative analysis again.

This kind of qualitative analysis is to experiencedly handle the factors which appear possibly in the prediction period or planning period supplied by planning policy-making department through examinating and surveying sample period.

The third is model internal-production. For example, the investment rate of every department was gained by using this kind of method. They are internally produced parameters after the model converges automatically to object.

Generally speaking, this application is initial development use and lack of experiences.The parameter estimation of prediction period is still very primitive. The application of sample period is not enough. But we think it is an important beginning. Because every statistic parameter in system can be surveyed in the model sample period, the effect degree and change tendency of these parameters to system can be tested, the object experiment of the model can make some parameters to became internal-production. These will open up a path for searching for nonlinar parameter estimation. Undoubtly, this is an important aspect of the future research of the model.

(Ⅳ)The data arrangement of the model

Statistical data is the foundation of establishing macroeconomic model. However scientific and perfect the model devise is, the model only stays on theory, and has no practical effect if data problem cannot be solved. Therefore we must spend a large amount of time and energy on collecting and arranging statistic data.

1. The basic content of data. According to the needs and possibility of the model, subject research team established four principles in arranging statistic data. They are: (1) In the system, the statistic data is supplied by material product equilibrium accounting system (MPS). (2) In department classification, material production department is classified as 17 industry departments. or industry includes 13 departments. Agriculture, construction, transportation as well as post and telecommunication respectively have one department. (3) In time series, sample period is from 1978 to 1989, having 12 year materials. (4) In price. contempory practical price is mainly adopted. Some indexes such as general production value, net production value and general national production value supply simultaneously the data calculated at unchanged price in 1980. The statistic data supplied by above rules includes 15 aspects:

(1) General output value of every department.
(2) Net output value of every department.
(3) Fixed asset primitive value of every department.
(4) The total amount of fixed asset investment of every department.
(5) Re-added fixed asset of exery department.
(6) Reimbursed fixed asset of every department.
(7) The depreciation fund of fixed asset of every department.
(8) The net value of fixed asset of every department.
(9) Input-output value form graph.
(10) Input-output direct comsumption coefficient.
(11) Fixed asset investment structure coefficient.
(12) Flow asset investment proportion coefficient.
(13) Fixed asset reimbursement rate of every department.
(14) Fixed asset depreciation rate of department.
(15) Consumption fund.

2. The main resource of the material.

The whole series of materials is supplied by Wuhan Municipality Statistics Bureau, Wuhan Municipality Statistic Bureau do its best to collect history materials. The foundamental part comes from yearly report form of 1978-1989 and history material compilation, auxiliary part comes from those data submited by municipal management department and County Statistical Bureau. These materials (not include those materials in 1989) now are collected in Books《Wuhan 40 years》

(Wuhan Univer-sity Press). 《Wuhan statistial materials (1949-1988)》 (Book1-4) and 《Wuhan input-output graph in value form》. These books are compilated by Wuhan Municipal Statistical Bureau.

3. Main handling methods

(1) Adjusting statistical index standard. Before 1984, the general output value of country and below country is calculated in agricalture output value as by-industry. Because of the change of country economy structure, nation stipulated that the genaral industry output value of country and below country would be completely listed in industry statistic scope. Therefore, the materials in this model have been seperated and adjusted.

(2) Integrating industry department classification. Industry general output value from 1978 to 1984 is classified by trade from the beginning of 1985. It is converted to department classification. According to correspondence principle, we arranged out 《15 industry departments and 40 industry trades contrast table》 as basis of adjusting trade as department. Then based on 15 departments we merge sewing with leather, paper-making with culture and education, and make them to become 13 industry departments determined by the model.

(3) Paying attention to statistical data joining. If statistical materials from a complete set, the logical relationship of data must coincide. For example, fixed asset primitive value at the end of this year should equal to fixed asset primitive value of the end of last year plus the increased fixed asset (newly increased and input) and substract the decreased fixed asset (reimbursed and output) in this year. In these aspects, there are some unjoining problems in the stastistic materials of Wuhan. Thus we assembled related book 《National industry enterprise fund equilibroum table》 from Wuhan Municipality Finance Bureau and according to it, we also calculated yearly indexes such as fixed asset reimbursement rate and depreciation rate of every department on the basis of not changing fixed asset primitive value we adjusted the increased value or decreased value of fixed asset, and improved logicality of data.

(4) Suitably estimating insufficient materials. The model needs to supply input-output direct consumption coefficient in sample period and prediction period. Although Wuhan began relatively early in input-output. there are only three year materials. Thus we adopted interrelated year direct consumption coefficient to estimate them or adopted practical material consumption proportion of every department as control. The input structure in 1983 is quoted from 1984 to 1986, that in 1987 from 1988 to 1989, that in 1983, 1985 and 1987 comprehensivly from 1990 to 1995. The needs of the model to statistical matevials are basically met.

But the lack of inherent complete ststistic system and good stastistic basis causes poor stastistical date quality and influences the accuracy of prediction results to some degree.

(V)The model examination and explanation

"Practice is the sole standard of examinating truth". Of course, practice is the most ideal way of examinationing the model. On the basis of above consideration. Comparing the prediction results of the model with practical value is the examination method we edopted in the model.

The model uses the samples from 1978 to 1985, and takes the practical input from 1986 to 1989 as input condition. "The Seventh five-year planning" period, or from 1986 to 1990 was simulated in the model. Now we only regard social general output value in unchanged price as analysis object.

1. From the point of four year accumalative total amount, the practical total amount in early four years during "the Seventh five-year planning" period, is 102.88 billion, and the emulation value of the model is 102.86 billion, the error rate is only 0.1%.

Among them, agriculture practical value is 5.44 billion and emulation value is 5.487 billion, error rate is 0.9%. Industry practical value is 81.18 billion yuan, the error rate is 2.6%. Practical value of transportation and Post-telecommunications is 3.536 billion yuan and emulation value is 3.652 billion yuan, the error rate is 3.3%. Commercial practical value is 7.745 billion yuan, and emulation value is 7.89 billion yuan, the error rate is 1.9%.

2. From the point in yearly unit, the practical total of the whole city in 1986 is 22.7 billion yuan, the emulation value is 22.76 billion, the error rate is 0.24%. In 1987 whole city practical total is 24.96 billion yuan and emulation value is 24.51 billion yuan. The error rate is 1.84%, In 1988 the practical total is 27.51 billion and emulation value is 26.88 billion. The error rate is 2.34%. In 1989, the practical total is 27.71 billion yuan and emulation value is 28.71 billion yuan, the error rate is 3.61%.

3. From the point in yearly unit and department, there are 68(17*4) year times in the early four years during "The Seventh five-year planning" only, the error of 18 year-times among them is beyond 10%. The percentage is 26%. The error of 21 year-times is from 5 to 10 percent. The percentage is 31%. The error of 23 year-times is from 1 to 5 percent. The percentage is 34%. The rest error is below 1 percent. The percentage is 9%.

Above three kinds of analysis show that the error of accumulative total from 1986 to 1989 is very small, less than 1 percent. The more detailedly the trade departments are classified. The more shortly time is divided, the greater the error is.

The model starts from micro department and reflects macro-whole regional macro economy. Even if micro-error is rather great, the mocro-accurancy reflected is also rather high. Therefore we can say that the model is successful to draw up whole planning, especially middle, long-term planning, starting from trade

department. That "the micro" reflects "the macro" shows the advantage and practicality of the model.

(Ⅵ) The new function of system software DYNAMO-S1.

Because of complicated structure, long sample period, large amount of date and various functions and usages (used in prediction and experiment) of multifunction equilibrium growth model. We also added database and model base function in new system software. In order to meet more perfectly different requirement on basis of previous emulation optimum and control function.

The main function of database is to fillful data input, output in the procedure of emulating and various data handling through combining database and management system with model system.

The main function of the model is to store various submodel and model bunches having different function and action. In the model base, in the process of model operating, according to the requirement, various submodels and model bunches constitute automatically a model which executes certain function and fillfuls certain tast.

Reference:

1.Guo Qincai. 1989, 《Realisfic Equiliblium Growth Theory, Model and Software》 Wuhan Press.