THE MECHANISM AND PROGRAM OF DEMAND AND SUPPLY OF TALENT IN ESE (EDUCATION-SOCIETY-ECONOMY) SYSTEM

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ABSTRACT

The regional demand-supply and training mechanism of talent is regarded as a feed-back-cnotrol structure under the synergetic actions of education, society and economy. By building ESE simulation system, we have studied its stability in operation and its sensibility to main parameters. we have attempted the combination of SD with LP (Linear Programming), and some initial conclusions are reached which can be further discussed.

Using the principles of the Education-Economics and SD methods to forecast and program the demand-supply of talent is becoming very popular in the educational theory circle of our country recently. There are many scholars whose studies have really shown the originality of SD method, but there are two problems that little attentions have been paid in thier studies. One is that forecasting is not the strong point of SD, and it is also not competent for programming by SD methods only, the other is that we often pay more attention to the supply but neglect the demand between Education and Economy, which easily results in the lack of enough impetus to the system operation. Our paper tries to do some studies on overcoming the above two inadquate aspects.

A. The Structure of SD Simulation Model

The simulation model in our paper (ESE System) consists of three subsystems --- Education, Society and Economy. Each of them is open and in order. The stability and development of each system is dependent on the exchange of energy, material and information among these systems. The exchanges form very complicated demand-supply chains. If any one of the demand-supply link is not satisfied, the whole system will be disterbed, even out of order. The coupling of the three subsystems

is shown in figure 1.

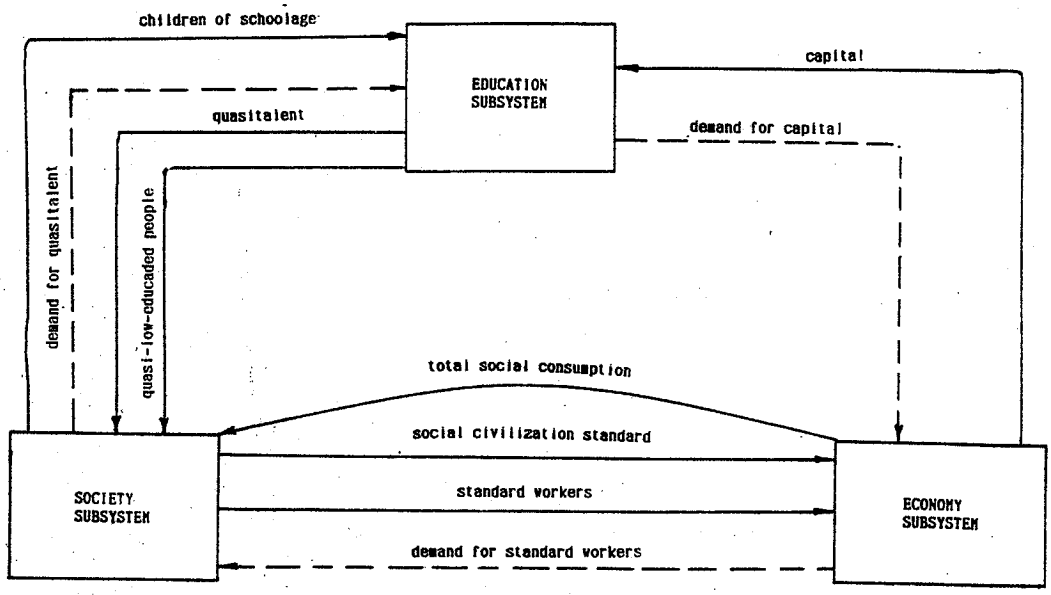


Figure 1. The Coupling of the Three Subsystems

> Education Subsystem

There are ten basic elements in Education subsystem, they are students of seven kinds of schools (1. 9-year compulsory education; 2. ordinary high school; 3. secondary teacher's school; 4. secondary technical and specialized school; 5. ordinary colleges and universities; 6. normal universities and 7. adult education), two kinds of teachers (teachers with higher education and with secondary education) and educational facilities. There are two feedback mechanisms in their couplings, one is the control mechanism of education ability, the other is the reproductive mechanism of educational ability. The educational ability of a school is defined as the number of students the school can take in. This depends on its quantity of teachers and facilities. Based on the real data, the weight ratio of these two aspects influencing ability training is 6:4. The numbers of its enrolment and graduated students are the students flow influencing the standard of the students at school. The postponement of time depends on the school system, as shown in figure 2. It is easy to imagine that the reproduction of educational ability means the supplement and renewal of teachers and facilities. The supplement of teachers comes from students graduated from normal schools and universities and some ordinary colleges and universities. The postponement of supplement time is fixed to one year, the relation of which is shown in figure 3. The basic behaviours of Education subsustem derive from the combination of these two feedback mechanisms. The structure of Education subsystem is shown in figure 4.

>Society Subsystem

The output of Education subsystem --- "quasitalent" (students graduating from

schools of kinds 3--7) and "quasi-low-educated people" (students graduating from schools of kinds 1--2, but can not get higher education) --- becomes the input of "talent" and "low-educated people" of Society system. Based on the present situation of Zhejiang province,of all the "low-educated people", except for some of those going to get adult education, their average education is 4 years. We take those workers with 4-year education as the standard workers. "Social civilization level" means the weighted average of the 4 indexes: "the average education of the average population", "the average consumption lever", "the number of talent in productive sectors in every 10,000", and "the number of talent in the non-productive sectors (excluding the educational sectors) in every 10,000". This is our attempt on quantifying social factors. The inner structure of Society subsystem is formed by coupling 5 basic elements --- the total population, talent in non-productive sectors (excluding the educational sectors), talent in productive sectors, low-educated people and social civilization level. This system structure is shown in figure 5.

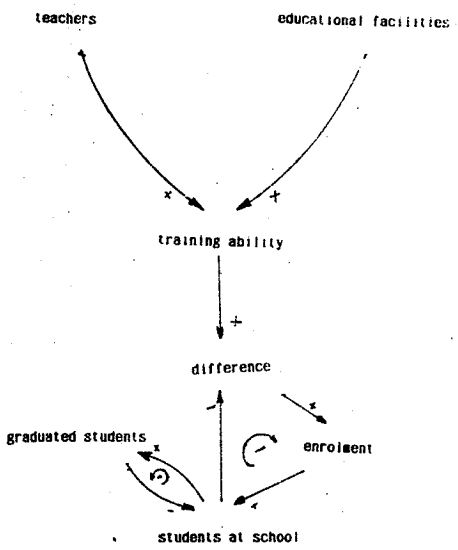


Figure 2. Control Mechanism of Educational Ability

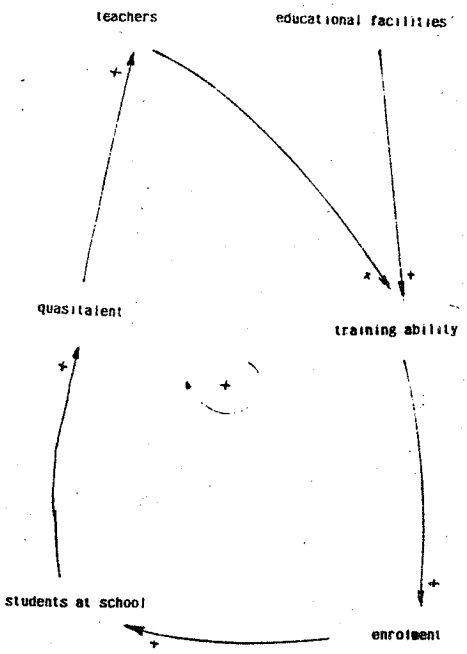


Figure 3. Reproductive Mechanism of Educational Ability

>Economy Subsystem

The basic elements of Economy subsystem is the total sum of the fixed assets of the productive sectors. It integrates with the standard workers and social civilization index input by society system and produces total output value which forms the national income. The national income is divided into three parts: investment in the next year's production, social consumption funds [including investment in non-productive sectors (excluding education) and the total social consumption f unds (excluding teachers')] and educational funds. One part of the productive investment becomes the additional fixed assets by postponement, the other part of which

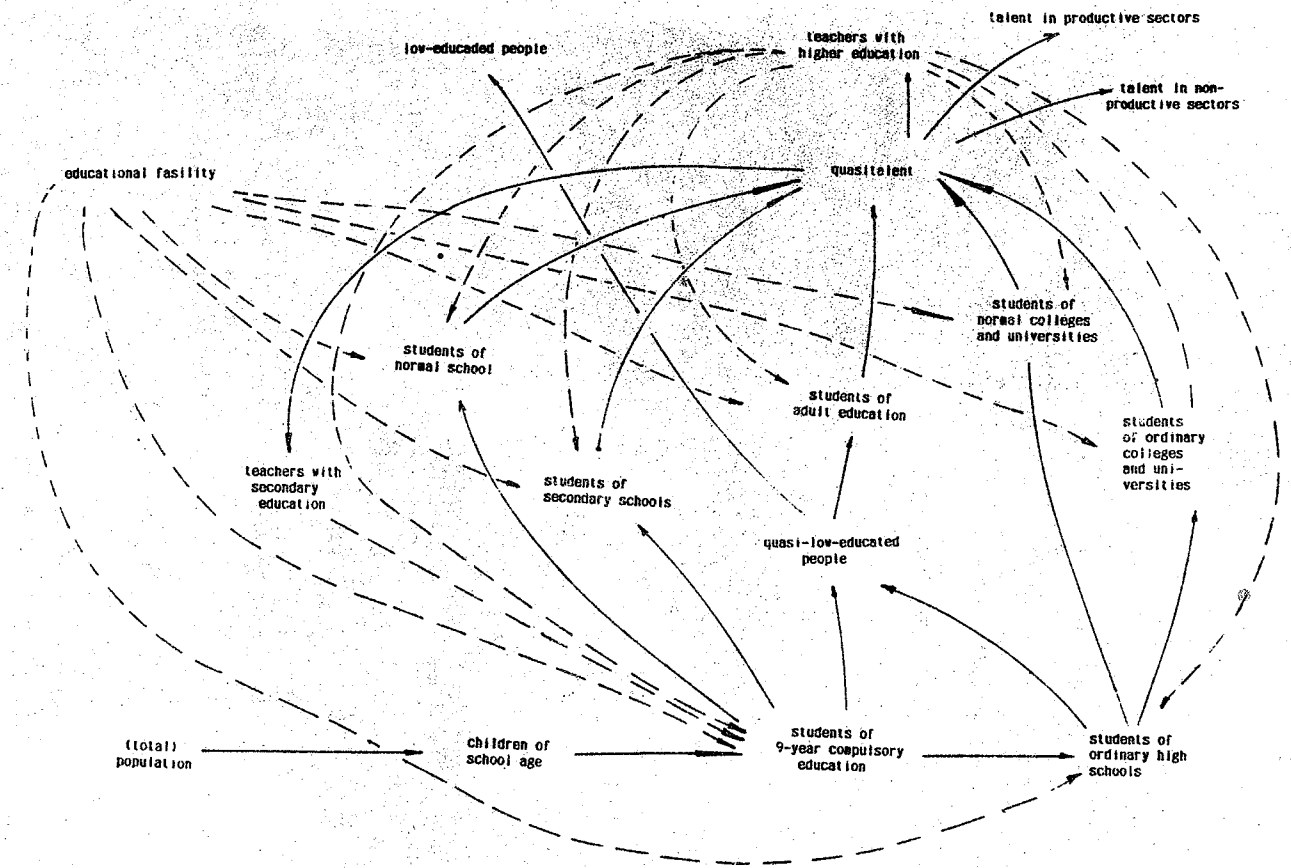


Figure 4. Education Subsystem Structure

becomes the circulating funds. Educational and social consumption funds are exported respectively to Education and Society subsystems. The structure of this subsystem is shown in figure 6.

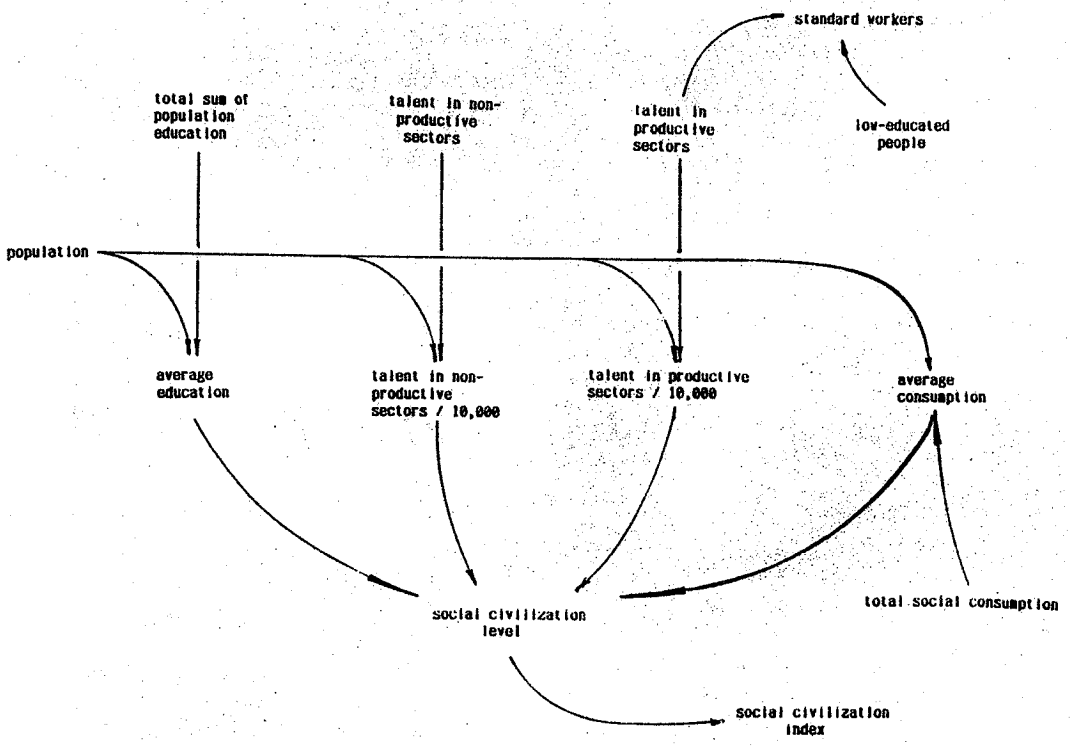


Figure 5. Society Subsystem Structure

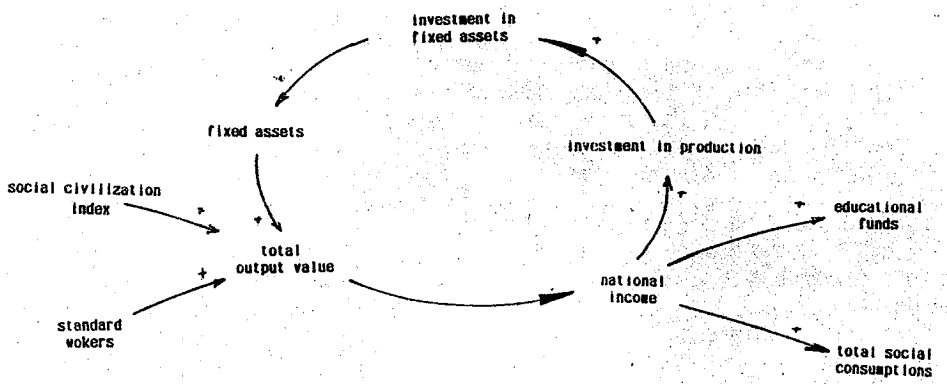


Figure 6. Economy Subsystem Structure

In our paper, the output of the total output value is expressed as the improved Cobb-Douglas production function

$$G_t = A_0 * B_t^{\gamma} * K_t^{\alpha} * L_t^{\beta}$$

there, G_t is total output value, B_t is social civilization index (the index of the base year is 1), K_t is the total fixed assets, L_t is the total sum of standard workers, γ, α and β are their individual partial elasticity coefficient of output, A is the ratio of overall elements to output of the base year. By regressing the data from 1979 - 1984, we set $\alpha = 0.32$, $\beta = 0.68$, $\gamma = 0.03$, thus, this production function is increasing returns to scale.

To describe the talent demand of Economy subsystem from Education subsystem, in our model we assume that under certain techenic state, the output of certain product requires corresponding technic talent. The difference between the talent demand and the present quantity of talent, as a latent demand, becomes the impetusto to Education subsystem, thus, influencing the enrolment of the subsystem. Here we put a 3-year postpoment which indicates the fact that it takes some time for people to realize the latent demand of education and to give practical impetus to it. Other assumption in this model is based on Marx's economy theory that complex labour is the multiplication of simple labour. So people with 9-year, 12-year and 16-year education equal to 2, 3 and 4 standard workers respectively.

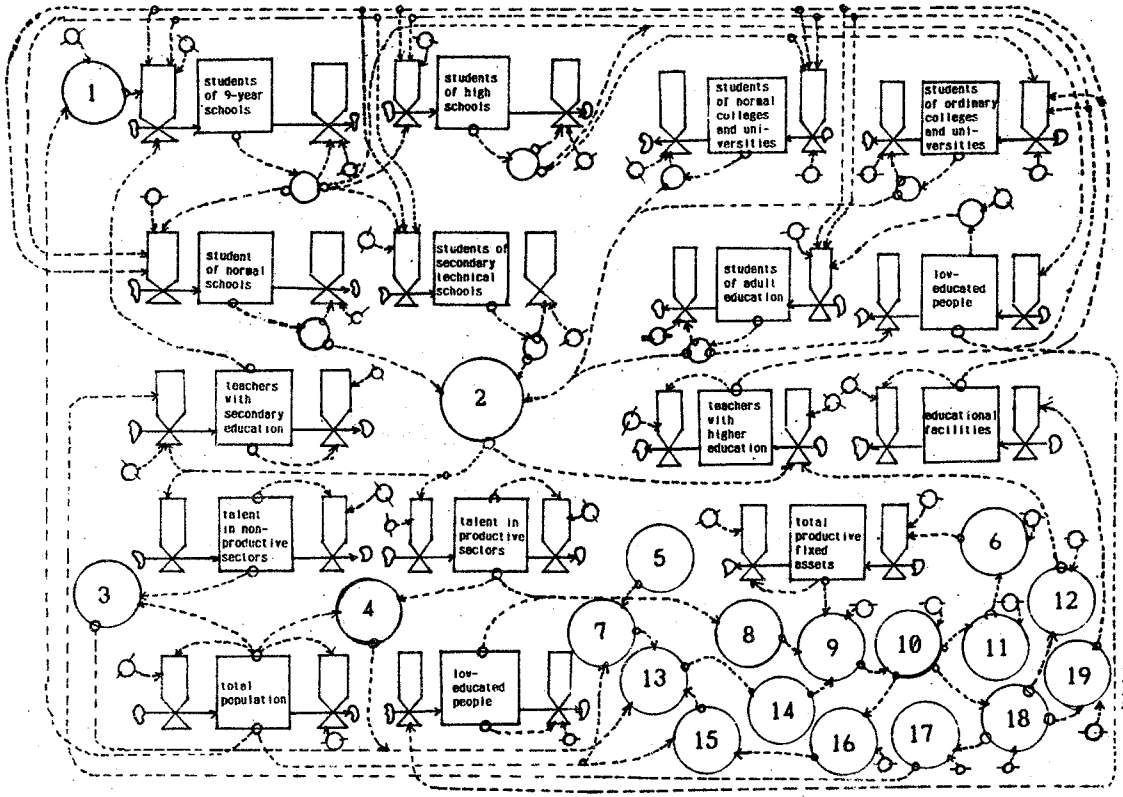
The about three subsystems form the whole ESE system . The overall flow diagram is shown in figure 7.

B. Experiment of System Operation and Stability

Take 1985 as the base year, we have got the various necessary parameters from the statistic yearbook of Zhejiang Educational commission. Input these paramenters into the model and operate it till 2000. The result shows that the operation of the system is stable under the above given parameters. The result of the operation is shown in figure 8. Therefore we have made some analyses and suggestions about the present state of education of Zhejiang province However, our main interest is in the experiment of system stability.

Systems stability should be conditioned. The evolution of the system from order to disorder and back to new order is the general law commonly existing in nature and society. Studies of this evolution have always been the most enchanting field of the frontiers of science. One of our basic thoughts to establish the ESE system is to observe and grasp the law of the development and variation of education,economy and society of Zhejiang province by experiment of SD model. Up to now, we have made nearly a hundred experiments and successfully observed some regular variation of ESE system.

The emphases of our experiments is to observe the system's sensibility and effect to the variations of three kinds of parameters.The basic method is: to a parameter J, choosing a sequence $\{J_1, J_2, \ldots, J_n\}$, while fixing other parameters, test the reaction of certain variable L . If the parameter can influence the operation of the system, we can get a corresponding locus sequence $L_i = L(J_i)$, $i=1,2,\ldots,n$, which is a subset of the phase space of the system. Analyse the subset, we can find an open interval (J_k, J_l) so that the locus of $L(J_i)$ varies slightly. The interval is just the stability interval of the system, and the system is not sensitive to the



1.children of school age
2.quasi-talent
3.talent in non-productive sectors/10,000
4.talent in productive sectors/10,000
5.total school year
6.investment in fixed assets
7.average education
8.standard workers
9.total output value
10.national income
11.productive accumulation
12.funds for teachers with higher education
13.civilization standard
14.social civilization index
15.average consumption
16.total social consumption
17.funds for teachers with secondary education
18.educational funds
19.investment in educational facilities

Figure 7. ESE System Overall Flow Diagram

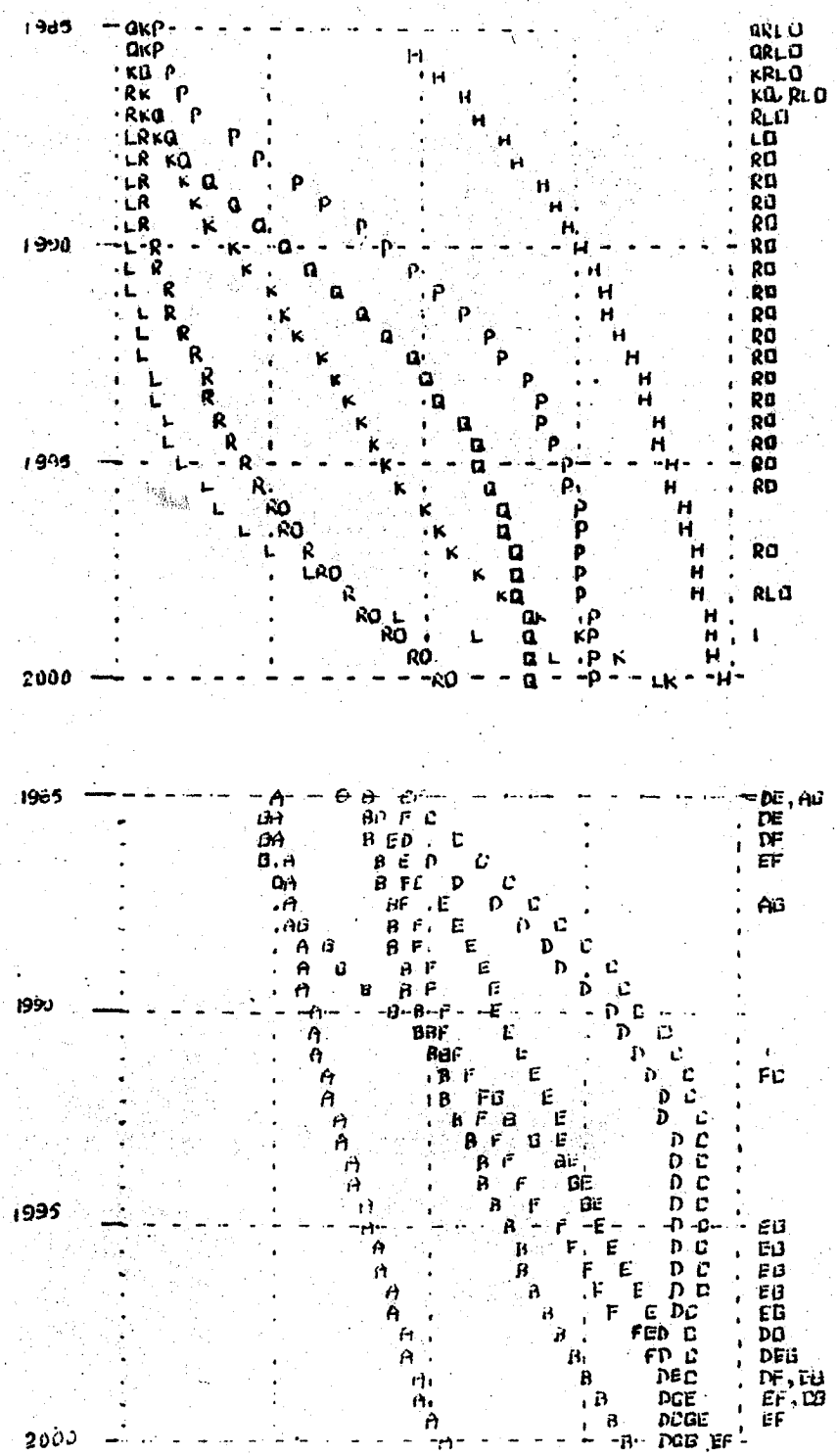


Figure 8. General Action of ESE System

parameter within the interval. Both J_k and J_l are critical point of the stability of the system. Nearby them, the system may lose its stability, and a violent oscillation is likely to happen. Once the critical point of main parameters of the system is found out, we can possibly grasp the operetion principles of the system, and can make some policy analyses and suggestions.

The three kinds of parameters of our observation are:

1.The ratio of educational funds to national income. Our experiment shows that,the stability interval of the system is (0.01, 0.04). The effect of the experiment is shown in figure 9.

2.The postponement of demand for talent. Our experiment shows that , it has great influence on the system. It also means that, education most follow the talent demand by economy development as fast as possible. If not so, the economy development maybe delayed, and even fall into some vicious circles. The experiement effect is shown in figure 10.

3.The inner structure of Education. We express the allocation of educational funds and quasiteachers as a 7-dimensional number group, and every different group indicates every different project. We have investigated the influence on this system by three projects different from the present state, with emphasis on (1) education for teachers, (2)secondary or specialized schools, and (3) education for adults. The results of experiments show that, the project (1) may make the system lose its stability, the project (3) will make the system operate better than before.

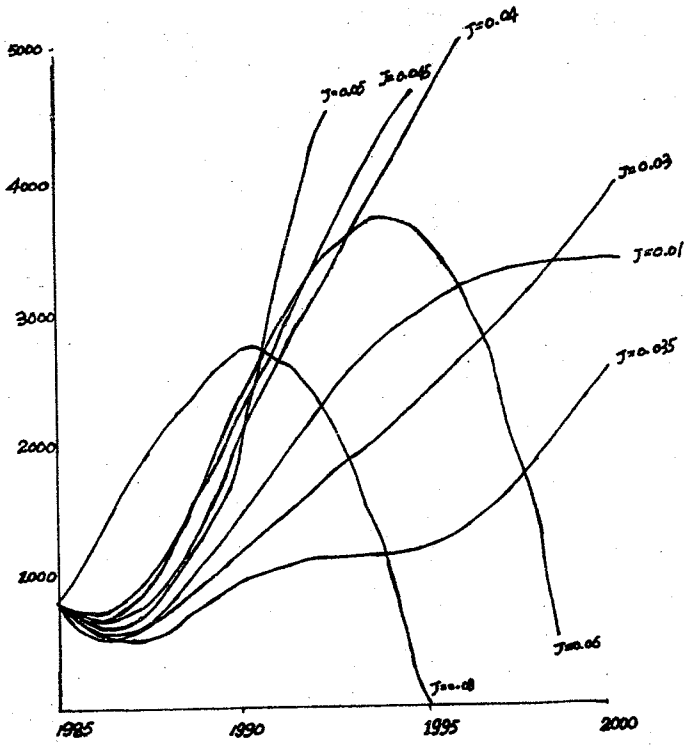
From the study and experiment up to now, we have also realized that:

1.The SD method can not be used in forecasting and policy experiment at the same time, because that the forecasting requires the operation of the system to be stable, and insensitive to the variation of parameters, whereas the policy experiment requires the system to be highly sensitive to them. The reason that people often feel pity about the inaccuracy of SD model in forecasting is not usually because the statistic data are inexact, but because a system can not go into two different phase at the same time. In some sense, this is somewhat similar to the "Impossibly-exactly-measured principle" of physics.

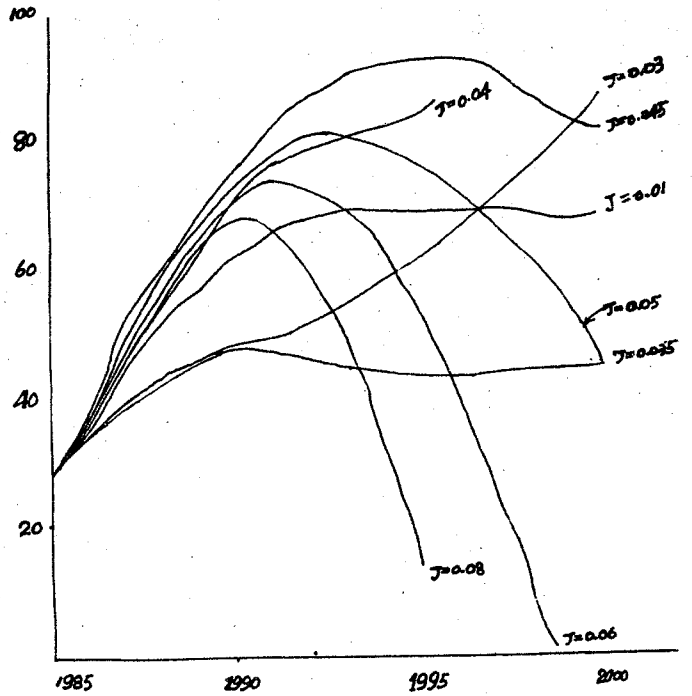
2.The action of a system is determined mainly by the main links of the system. In our ESE system, the main link is the demand and support between education and economy. If this relation is simiply expressed as the support between each of them while ignoring the demand, then the system must be rigid, and in a low-leveled stable state. Although various index variables increase by exponent, yet we will be unable to draw any worthy conclusions.

C. An Initial Study on Combination of SD Method with LP Method

The combination of SD method with other mathematical methods has been opening a broad prospect for the development of SD, so it has become a popular topic now. While studying SD, people often regret that the SD method can only be used in making some parameter tests, but can not optimize these parameters. On the other hand, while studying the quantitative economics, people often have to make the LP method dynamical. Our paper attempts to blend SD with the dynamical LP.

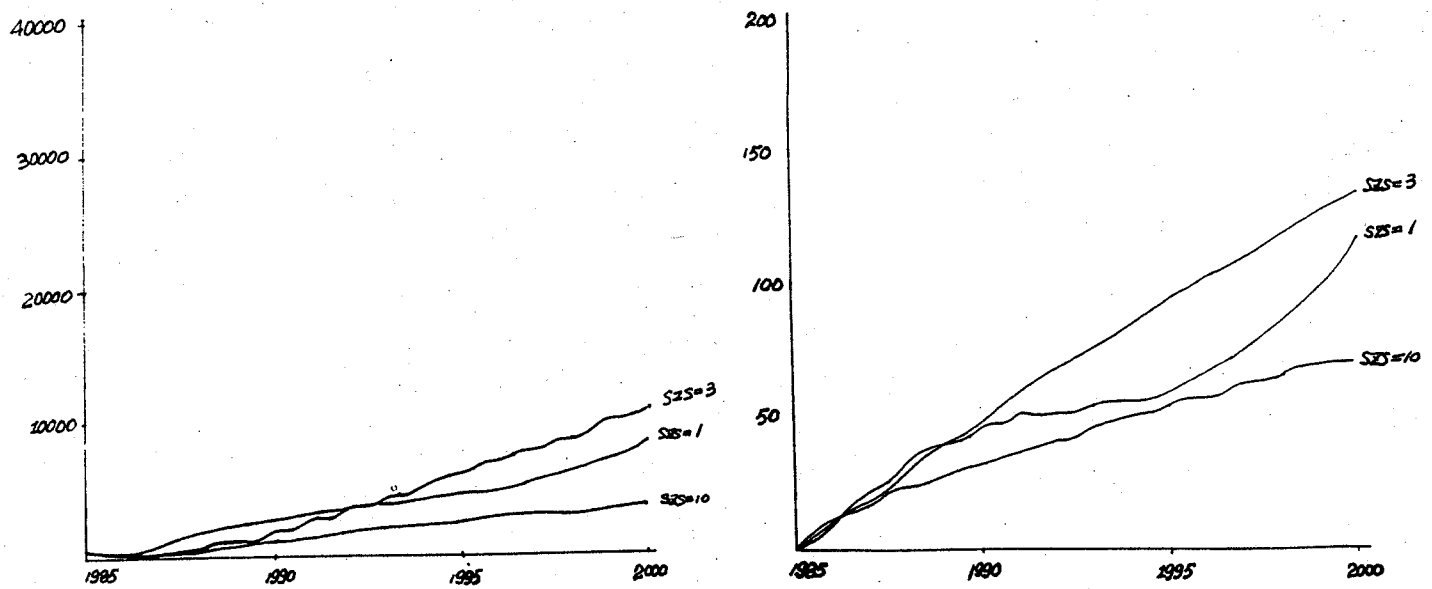


a.the influence upon the social civilization index



b.the influence upon the talent in productive sectors/10,000

Figure 9. The Influence of the Ratio of Educational Funds to National Income



a.the influence upon the social civilization index

b.the influence upon the talent in productive sectors/10,000

Figure 10. The Influence of the Postponement of Demand for Talent

Our study is done by two different ways. One way is to establish several LP models corresponding to some important parameters (We have established three LP models --- the Production and Allocation of National Income Model, the Allocation of Education Funds Model and the Allocation of quasitalent Model.). First, we put the parameters of base year into the SD model, and take the results of SD model's operation as the restraint condition and optimize the parameters, then use the optimized parameters to replace the original corresponding ones and put them into SD model. The result of the new operation is put into LP model to have the parameters reoptimized.

We have made such an attempt in a quite short programming period, the result shows that the process of the replacement quickly becomes convergent. But we are not satisfied. For this means the optimizing of the parameters is not close to the critical point, and the system is not sensitive to the optimization of the parameters, so, optimization itself becomes senseless. Theoretically speaking, if we want to get such a combination, the system should be first pushed close to the critical point, make it sensitive to parameter variation, so, the meaning of optimization is to seek a range so that when some values in it are taken by those parameters, the system may be pushed into a new order, a higher-leveled stable state. Unlike pure SD experiment, the combination can make SD experiment into a parameter optimizing process with goals. We will make further attempts later.

The other way is to transfer the whole SD model into a dynamic LP model, and SD model replacement into LP model replacement. The brief outline of our thinking is as follows:

1. Economize the educational sector. Convert the "price" of the graduated students from various schools on the basis of training cost and chance cost, thus, the output of Education subsystem can be expressed as the total output value of the year.

2. Establish dynamic input-output balance equation by taking into consideration the input-output relation among all productive sectors (industry, agriculture, building industry, transportation, post and communication, commerce and service trades) and educational sector. We have made an assumption that , under certain technical and educational state, their direct drain coefficients are almost stable. This is in accordance with our assumptions above.

3. Connect the input-output balance equation with educational funds allocation model and quasitalent allocation model. The various inner links used to be described by SD model are expressed as demand-supply restraint among the subsystems. Thus we get a dynamic overall LP model.

4. Starting from base year, the three subsystems first operate on their inner structures and influence each other afterwards, forming the state of the whole system in the next year. We multiply the yearly replacement of the programming period, take the maximum output value sum of the productive and educational sectors of the last year as the goal, thus the whole operation of the SD model can be displayed almost, while having the function of optimization.

It is a regret that the scale of the LP Model thus formed is really too large that because of the limit of time and means, we are unable to work out the overall model but experimented on parts of the model only, the results of which are similar to those of SD Model, for example, the experiments show that education for

adults should be emphasized while education for teachers should be limited. We believe that, so long as the computer has enough capacity, this method will work. Also, we hope that the result of such dynamic LP models which are stably restrained will be in accord with the Turnpike Theorem, of course, this should be further verified.

Our results and understanding in this paper are quite initial and we will continue our study following the thinking described in the paper. We wish to express our gratitude to the countless friends and colleagues around us who have given us their help and valuable support in the course of our work. Our indebtness is due particularly to Chen Yuwu (Educational Commission of Zhejiang Province), Wang Shenling, Wang Ling, Zhang Weihua (The Computer Center of Planning-Economic Commission of Zhejiang Province) and Chen Haihong (Zhejiang Institute of Technology). We would like to take this opportunity to express our heartiest thanks to all of them.

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