STUDYING THE IMPACT OF SCIENCE AND TECHNOLOGY ON THE ECONOMIC GROWTH IN A CENTRAL CITY

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ABSTRACT

This paper study how to develop education, technology and economy coordinativetly in central cities. It outlines the kind of issues which analyze and study the ways of describing science and technology level. The importance of the paper has two points: one is a new method being applied to calculate industry output, another is the study guiding line to the three sectors(science and technology, education and economy) in their entirety. The policy suggestions will have significant reference to make central cities' long term development strategies.

INTRODUCTION

How science, technology and education promote the growth of economy has been very important for a long time. Many significant documents and papers have been published. They include quantitative and qualitative researches. Two apparent features can be found in those study. One is that calculating industrial output always connects with Cobb-Dougles production function. The other is that science, technology, education and economy are not studied completely as an entirety, because this is a very large and complex system consisting of many nonlinear loops. But we think that these two features have some deficiencies. First, because of different background between west countries and China, using Cobb-Dougles function may cause rather big error. Therefore this paper put forward a new way to calculate industrial output in order to seek the function of economy and scientists and technicians in promoting the growth of economy as a whole. Second, this large system for a typical central city has been studied completely.

THE CONTENT AND PURPOSE OF THE STUDY

By using the concepts and methods of the system dynamics, the model in this paper quantitatively studies the scientifical and technological ability of central cities and seek a way to quantify how science and technology ability and personnels influence the growth of economy. By model simulating, some policies are provided. The model discusses the following issues--the proper investment proportions of education, science, technology and economy; the function of science in the economy; the impact of scientists and technicians on promoting the economy; the proper industrial investment proportion of high,

middle and low technology in the economy system, and the synthetical study of the above .

BASIC HYPOTHESIS

To seek a new method of expressing quantitatively the function of science and technology in promoting the growth of economy, the sorts of scientists and technicians from different industrial sectors are classified correspondingly and the industrial development is considered comprehensively under the conditions of production. The basic hypothesis consists of:

a) Industrial departments are classified into three kinds--high, middle and low. Middle and low technological departments are named conventional industry. The characteristics of new industry are: high technology, high investment and high output. The better the proportion of the new and more developing industry takes in the whole industry, the higher industrial level it indicates and the less energy and raw material uses and the higher output of fixed capitals is. The middle technology department means that a large quantity of machinary equipments need to be shifted, funds are highly taken up and the production improvement depends on how much fund is added. The low technology department means it is a labor force intensive sector.The more output,the more labor force.

b) All the employees in the industrial branches are classified into three administrative levels, these are senior, intermediate and junior scientists and technicians. The senior are those who have received higher education. The intermediate are those who graduate from professional school. The rest are named junior.
c) The function of social environment in industrial production is not considered directly. The limits of energy, raw materials and transportation to industrial production are comprehended by the variable PCF of industrial producing conditions.

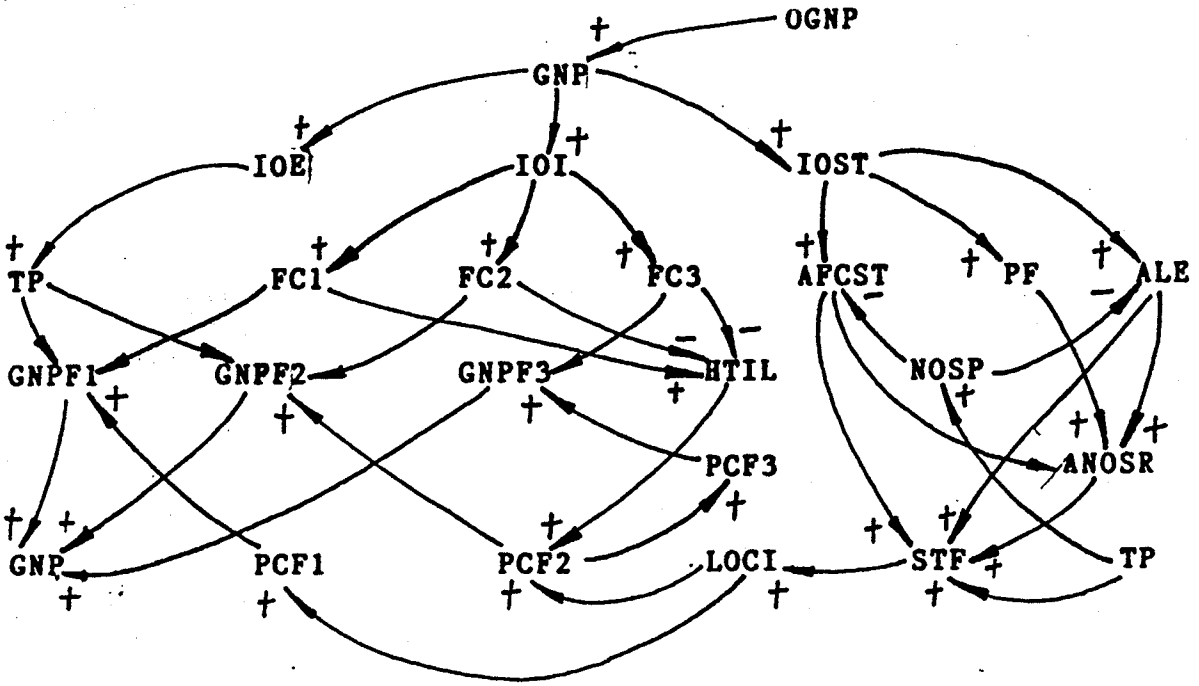

Figure 1. Causal Loop Diagram of the Model

STRUCTURE OF THE MODEL

The model consists of three sectors--education, industry, science and technology, which includes 18 levels and about 300 equations. Simulating period is from 1985 to 2005. The causal loop of the model is shown in Figure 1 and some main variables are explained as follows:

IOE----INVESTMENT ON EDUCATION
IOI----INVESTMENT ON INDUSTRY
TOST---INVESTMENT ON SCIENCE AND TECHNOLOGY
OGNP---OTHER GNP
PF-----PROJECT FEE
NOSP---NUMBLE OF STUDY PERSONNEL

1. Industry Sector

This sector is the key of all the three sections. Industry production relys on three elements: personnel, fixed capital and producing condition factor (PCF, which comprehends the limits of energy, raw materials, transportation and so on). High, middle and low technological departments are named industry(1), industry(2), industry(3).High, middle and low personnel are named personnel(1), personnel(2), personnel(3) respectively. Each kind of personnel in different industry department has its own productivity(p), as shown in Table 1.

TABLE 1. Productivities Related to Pesonnels in Different Department

industry\ personnel	personnel(1)	personnel(2)	personnel(3)
industry(1)	P11	P12	P13
industry(2)	P21	P22	P23
industry(3)	P31	P32	P33

Each kind of personnel has different demands in different industry department, as shown in Table 2.

TABLE 2. Demand Proportions of Personnel in Different Department

personnel\ requirment rate	industry(1)	industry(2)	industry(3)
personnel(1)	HPD1	HPD2	HPD3
personnel(2)	MPD1	MPD2	MPD3
personnel(3)	LPD1	LPD2	LPD3

The number of each kind of personnel assigned to different department are determined by its demand and the fixed capital in the department.

A NHPi.K=Si.k * HPRRi.K * HPMFi.K

NHPi--number of Higher-personnel in industry(i)

A HPMFi.K=Min ((HPAi.K / HPRi.K),1)

HPMFi--high-Personnel meeting factor in industry(i)

A HPAi.K=Hi.K/H.K

HPAi--higher-personnel assigned to industry(i)

A Hi1.K=Si.K *HPDi.k * TNHP.K

A H.K=S1.K * HPD1.K + S2.K * HPD2.K +S3 * HPD3.K

A HPRi.K=Si.K * HPDi.K

HPRi--higher personnel requirement in industry(i)
TNHP--Total number of higher-personnel
Si--Staffs in industry(i)
i=1,2,3

Si is determined by FCI (FIXED capital in industry(i)) with the same way, we can get NMPi.

NMPi--number of middle personnel in industry(i) and

A NLPiK=Si.K--NHPi.K--NMPi.K

NLPi--number of lower-personnel in industry(i)

So we get the formula of industry output:

A GNPF1.K=(NHP1.K * P11.K + NMP1.K* P12.K +NLP1.K * P13.K)* PCF1

A GNPF2.K=(NHP2.K * P21.K + NMP2.K* P22.K +NLP2.K * P23.K)* PCF2

A GNPF3.K=(NHP2.K * P31.K + NMP3.K* P32.K +NLP3.K * P33.K)* PCF3

PCF(i) is limited by the following factors: science and technology factor (STF), the shortage of supply and demand of energy and raw material and pollution factor.

PCF1=F1(LOCI,STF)

LOCI--Level of conventional industry

LOCI=F2(STF)
PCF(2)=F3(HTIL,LOCI)

HTIL--higher-technology industry level

The relation between high industry and conventional industry positive feedback. They interact each other.

2. Science and technology sector

STF is defined:

A STF.K=C1 * TP.K + C2 * ALE.K + C3 * AFCST.K + C4 * ANORR.K

C1, C2, C3, C4, are constant.

TP--Total personnel
ALE--average living expenses
AFCST--average fixed capital in science and technology sectow
ANORR--average number of research results

3. Education sector

There are three parts in this sect or : high education in college, intermediate professional school, and adult education, high-personnels are provided by college and high education from adult education, middle personnel are provided by intermediate professinal school and middle education from adult education.

VALIDATION AND THE EFFECTIVENESS OF MODEL

Quantitative verifications include:

(1). Extreme test in extreme conditions;
(2). Validation of model action;
(3). Validation by the comparision of simulating results of some important variables with their history value in the model. The error is less than 9%. Table 3 shows that:

TABLE 3. Comparision of Actual Valuves and Simulation Results of Main Variabbles in Base Run

TIME	VARIABLES	SIMULATION	HISTORY VALUE	ERROR(%)
1985		312.45	311.12	0.425
1986	GNPFI	317.77	318.89	0.352
1987	(.1*Billion	336.46	336.54	0.267
1988	Yuan)	362.75	361.27	0.408
1985		1.941	2.1078	8.59
1986	STF	2.150	2.1011	2.27
1987	(dimensionless)	2.214	2.1338	3.62
1988		2.249	2.1871	2.75
1985		55.00	55.00	0.00
1986	TP	62.10	63.84	2.80
1987	(10000	69.87	72.49	3.74
1988	Persons)	76.42	79.87	4.51

THE RRSULTS OF BASE RUN

GNPFI (.1 billion yuan) is 312.45 in 1985 , 681.06 in 2000 and

843.20 in 2005. The average growth of GNPFI in the period from 1980 to 2005 is 5.34%, It is too low to realize the long-term economic aim. STF(dimensionless) is 2.1078 in 1985 3.110 in 2000 3.7935 in 2005.HTPV(high technological personnel vacancy , 10000 persons) is 21.904 ,14.379 , 21.647 , MTPV (middle technological personnel vacancy ,10000 persons) is 115.61 , 113.51 , 145.00, respectively in 1985,2000,2005. There are three factors which may hamper the trowth of economy:

1). HTPV and MTPV are too big.
2). The growth of STF is too low.
3). Industry structure is not reasonable, conventional industry domionates whole industry where production conditions are bad.

POLICY TEST

In this part, we have five single tests and three comprehensive tests. The single tests are: improvire personnel cultivating policy; increasing industry capital investment; improving the ratio between high, middle and low technological departments increasing investment on science and technology; improving management quality. The comprehensive tests include three kinds: 6(1), 6(2), 6(3). In these tests, we compound single tests, and analyse main factors hampering or promoting economy growth in a central city. Test 6(2) only need the same capital support as present policy, test (1), 6(3) need morethan test 6(2).

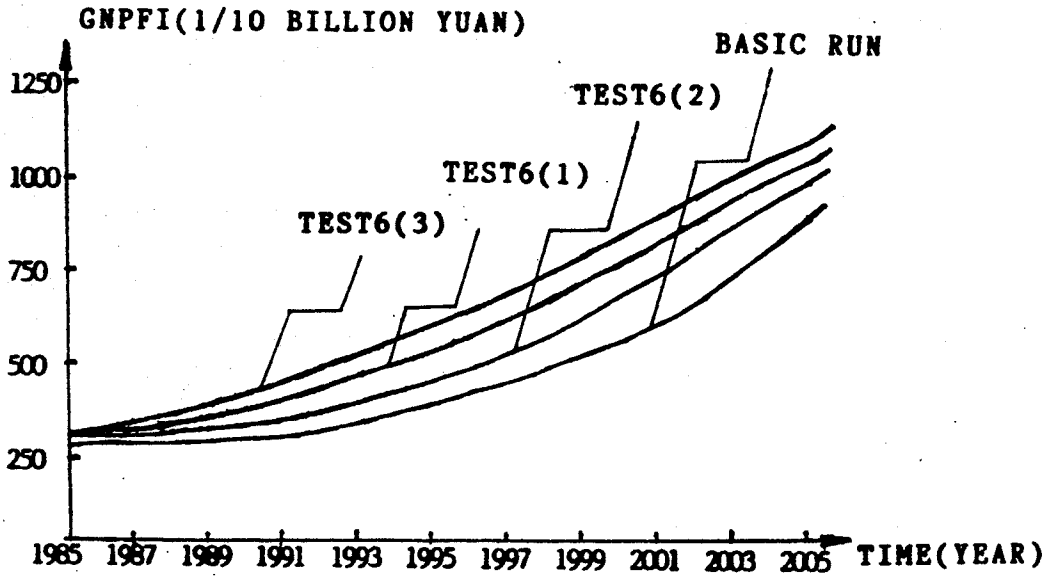

Figure 2. Tendency of GNPFI in Base Run and Three Comprehensive Tests

POLICY RECOMMENDATIONS AND CONCLUSIONS

Overinvestment in industrial sectors should be cut down and the limited funds should be invested in science and technology and education, the industrial structure should be adjusted, and the allocation of the resources and funds should be optimized. The concrete measures say as follows:

1). The cultivations of scientists and technicions especially in adult education, are speeded up, so that the total of the senior can be gradually lifted up one time or more, and that of the intermediate five times or more over present level. The proportion of the senior to the intermediate attains 1:5 in the long run, in order to meet the present industrial level and structure. Nearly in 1995, when the science and technology level evolves to a definite height, the proportion of cultivating the senior will be increased again, and that of the intermediate decreased relatively, so as to meet the urgent needs from new industries.

2). The investment proportion of science and technology in GNP is raised to 1% or more. The management of science and technology is improved. The channels of circulation, transfer popularization of results of research work are cleared up, so as to ensure the advance of science and technology level, improve production conditions in industrial sectors by means of advanced technologies and technological inovations, alleviate the conflicts between supply and demand of resources, improve the social environments, and develop the new industries as well.

3). Approximately in 1995, the proportion of investment of the new industries will be raised to 15-20% from the former 4.3%, and that of low technological industries will be reduced correspondingly. By diminishing and eliminating some conventional equipments with backward technologies, low efficiency, high waste of energies and materials, the advanced degree of the whole industrial structure can be enhanced. About in 2000, the more advanced industrial structure will be formed of which the proportion among technologically high, middle, low industrial sectors will reach 0.2:0.55:0.25, with high technology leading, middle moderating and low declining. Only through the measures and policies as above can the economic goal of the central cities' long-term Development strategy be fulfilled.

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