SOME OF THE LIMITS TO THE GROWTH OF BIG CITY IN CHINA

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ABSTRACT

In contrast with those fast growing of small- or mid-size cities' economy, big cities in China are suffering a lot of difficulties: the deterioration of the external condition of production, the decay of the industry structure, the shortage of municipal infrastructure, the fund scarcity, etc.. People have been discussing the limit factors of big cities for times, but we still need more quantitative and dynamic analysis of the whole system. In this paper we use the system dynamics model to simulate the behavior of a big city, conclude that within this century the main limits to the economic growth of a big city is the production condition, including energy, material, and transportation supply, while after the early years of the next century, the market demand, which is determined by the cost and the quality of product as well as the economic development of other areas, will be the real limit to a big city. Policy testing shows that the effective adjustments to big cities are the improvement of material supply as well as the speeding up of the capital discarding.

INTRODUCTION

Along with the implementation of the "open door" policy and the economic reform, the market mechanism is also being introdnced into China's economy. Compaired with the situation of 10 years ago, the economic environment has changed dramatically. Many small- or mid-size cities have gained a lot of benifits from the econemic reform, the speed of their economic development is rather impressing. In contrast with this flourishing situation, the big cities are far more stubborn. Generally speaking, the following difficulties are what they often have to combat with:

(1) The deteriorating of the external condition of the production. As a result of the rapid development of the country, the so called " resource provinces " are unwilling to provide their resources to the big cities (which was the common situation under traditional planning economy), instead, they want to utilize the resource themselves, though maybe ineffectively and inefficiently, and sell their industry product to the market. Naturally, this will hurt the big cities at both the begining and the end of the production: higher production

cost and smaller market share.

(2) The decay of the industy structure. As the indutrial centers, the big cities have contributed a lot to the industrialization of the country. But now their big capital stocks are gradually losing their virtue and are becoming the burden to them, because these capital stocks are that of the traditional industry, and are often over-used. It was estimated that in 1985, 70% of the industry equipment in Shanghai has only the technical level of 1960's, or even earlier, and only about 4% of the industry output was attributed to newly developing industry. Comparatively, the newly developing cities have newer industry structure.

(3) The scarcity of service. For a long time, people in China put too much emphasis on " making a consumption city a prodution one", and the social service was viewed as only consumpting rather than producing value, this results in the atrophy of social service. Until 1985, the social service has only 26% of the GNP and 25.7% of the labor force in Shanghai. As a comparison, the big city in the developed countries has offerred 70% of the employment opportunities, 65 % of the GNP is contributed by service. This severe shortage of service has caused the reducing of the social efficiency.

(4) The shortage of municipal infrastructure. The crowding of people, the congestion of transportation, the scarcity of housing and telephone and the severity of pollution have all caused more and more complaints of people.

(5) Fund scarcity. The above difficuties are not appeared in one morning, people have been talking about these for years. It seems impossible to solve them without huge amount of money. Where can we get the money? No simple answers.

Having this heavy burdens with them, it is not difficult to imagine why the big cities often develop slower than small- or mid-size cities. During the last three " Five-year plan ", the developing speed of both industrial and agricultural output value in big cities were slower than the average speed of the whole country. These problems have been discussed for years, and various kinds of factors which block the growth of the big cities have been studied, meanwhile several books have been published (see the reference). But generally speaking, these works use the extrapolation technique, not the dynamic methods; they study the effects of every factor individually, not interactively; they are more qualitative than quantitative. We need the quanlitative method to analyze the dynamic behavior of the whole system, the joint effects of the main factors. This paper is devoted to tentatively answer the needs. Because of the shortage of data as well as time, this paper focuses only on the economic aspects of the problems. Please note that the model is not constructed for a specific city, though we did have considered the situation of Shanghai city.

Model Structure

The model has about 350 equations, which contains 13 level variables. The main structure is shown as follows:

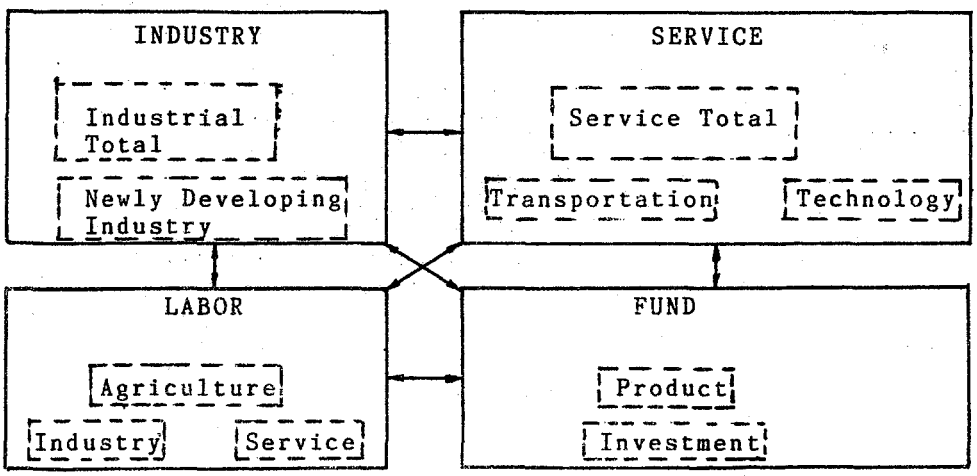


Fig.1 The Sectors of the Model

There are mainly four sectors: Industry, Service, Labor and Fund. For big cities, we assume the agricultural output is small, therefore we have not treat it as a separate sector.

The Industry sector is of greatest importance , which contains two subsectors: industry total, and newly developing industry which is a part of industry total.

We use four level variables to represent the fixed-capital for Industry Total: K1, K2, K3 and K4, as shown in the following figure:

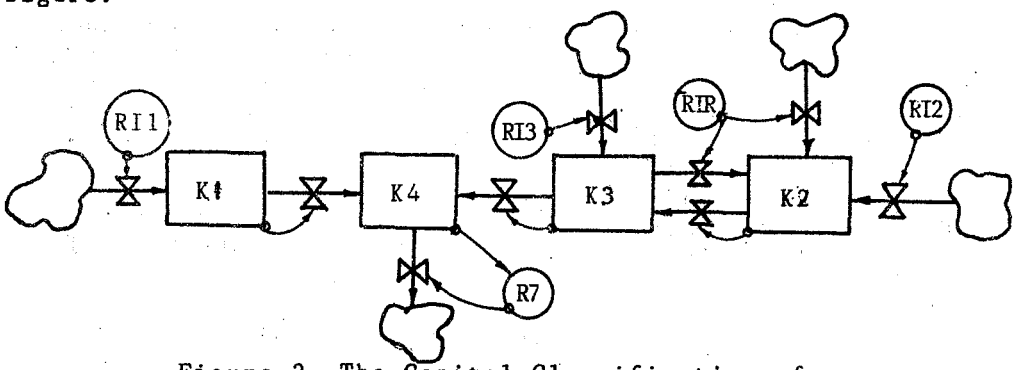


Figure 2. The Capital Classification of the Industry Total Subsector

The investment to industry is classified into four parts: RI1, the investment to the capital with the technical level of the nearest 10 years; RI2, the investment to capital with the technical level older than 10 years but newer than 20 years; RI3, the investment to capital with the technical level older than 20 years. RIR represent the technical-reform, which is different from the other three capital construction and can improve the technical level of some capital from K3 to K2. R7 is the discard rate. By this classification of capital, we can get two concepts: K1 and K2 represent the capital with the technical level of nearst 20 years: the bigger this portion is, the higher the technical level of the industry will be. K4 represents the capital which has been used more than 20 years: the bigger this portion is, the older the physical capital structure will be. In China today, newly invested capital may have the technical level of 20 years ago. Therefore we have to distinguish the technical age and physical age, both of them will affect the cost of production and the quality of product.

The capacity of the industry can be induced from the Cobb-Douglass equation:

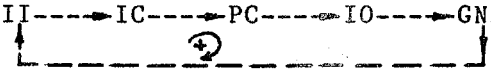
$$Y = A * T * K^{\alpha} * L^{\beta}$$

Here Y is the output, T is technical level, K is capital, L is labor, A is a coefficient. Besides the capacity, the real output is also affected by the synthetical capital utilization which is determined by the following three factors: the production conditions (the degree of energy, material and transportation satisfaction), the market demands (which are affected by the cost and quality of the product and economic development level of other areas outside the city), and social efficiency (the social service level)

The transportation capicity is determined by the corresponding investment, similiarly, the technology level is affected by its investment and technology import. The Sevice Total sector provides the contribution of service to the GNP, which is determined by the number of labor and equipment per labor. Labor sector gives rise to the number of labor in agriculture sector, industry sector, and service sector as well as the transfer of labor among the sectors. Industry has a higher priority than the service in the distribution of both labor and investment , which we believe reflects the real situation of China today.

There are mainly four loops which determine the behavior of the system, one positive loop, and three negative ones (see Fig. 2):

Loop 1 (positive): II----→IC----→PC----→IO----→GNP



This is the main loop which causes the growth of intrustry.

Loop 2 (negative): II----→IC----→PC----→URCI----→UIK

Loop 3 (negative): II----→IC----→PC----→URCI----→CP---→MDPCI
UIK

Loop 4 (negative): II----→IC----→Lab2--→Lab3---→SE---→UIK

The three negative loops above constrain the growth of the system. Weassume here that the labor supply and material (energy) supply are limited at any given time. Therefore the growth of Labor in Industry (Lab2) has a negative effects on Lab3. Similiarly, the increase of the production capicity (PC) has a negative effects on the satisfaction of production condition (URCI).

When Loop 1 dominates the other three loops, the system will show a growth mode. But as production grows, the condition for production becomes worse and worse, and the positive loop loses its dominancy, so that the capital utilization drops, which causes then the decreaseof the industrial investment.

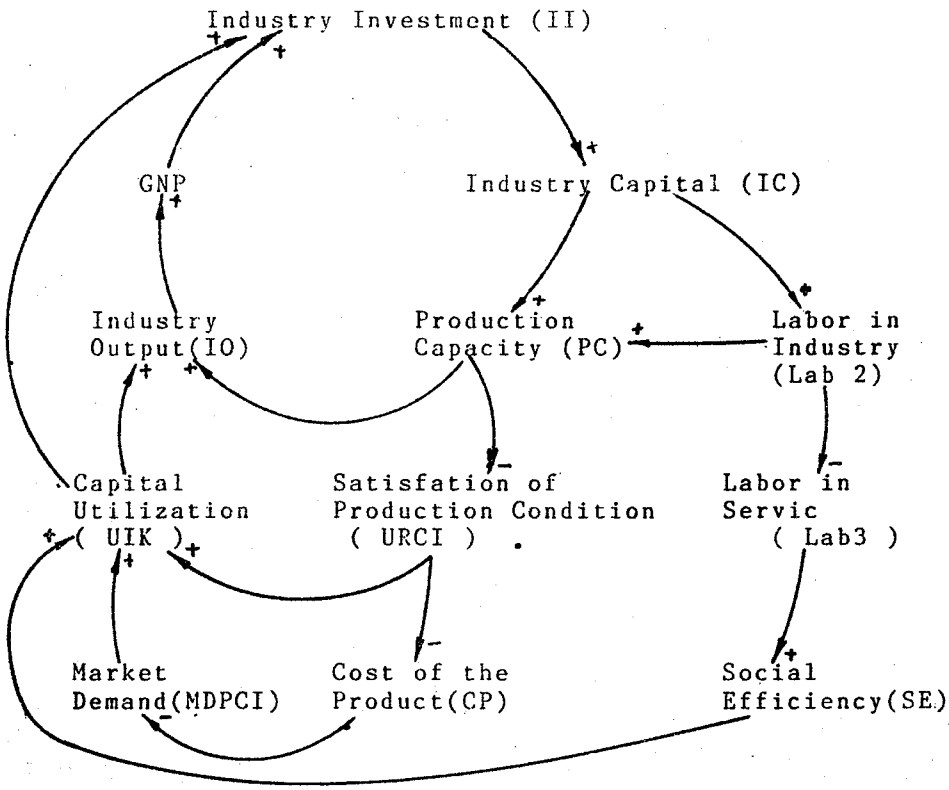


Figure 3. The main loops of the model

Base Run and Its Analysis

Fig 4. shows one of the Base Run results of the model. The time span is from 1980 to 2020. The variables in the figure have the following indications: AGNP -- the gross national product of the city, AGNPSE -- the parts of AGNP contributed by social service sector, ANNIC -- net national product of the city, AAPCI -- the actual industrial output, TEC -- technology. The value of each variable is not numerated in their absolute value, but in their relative value compared with their initial value.

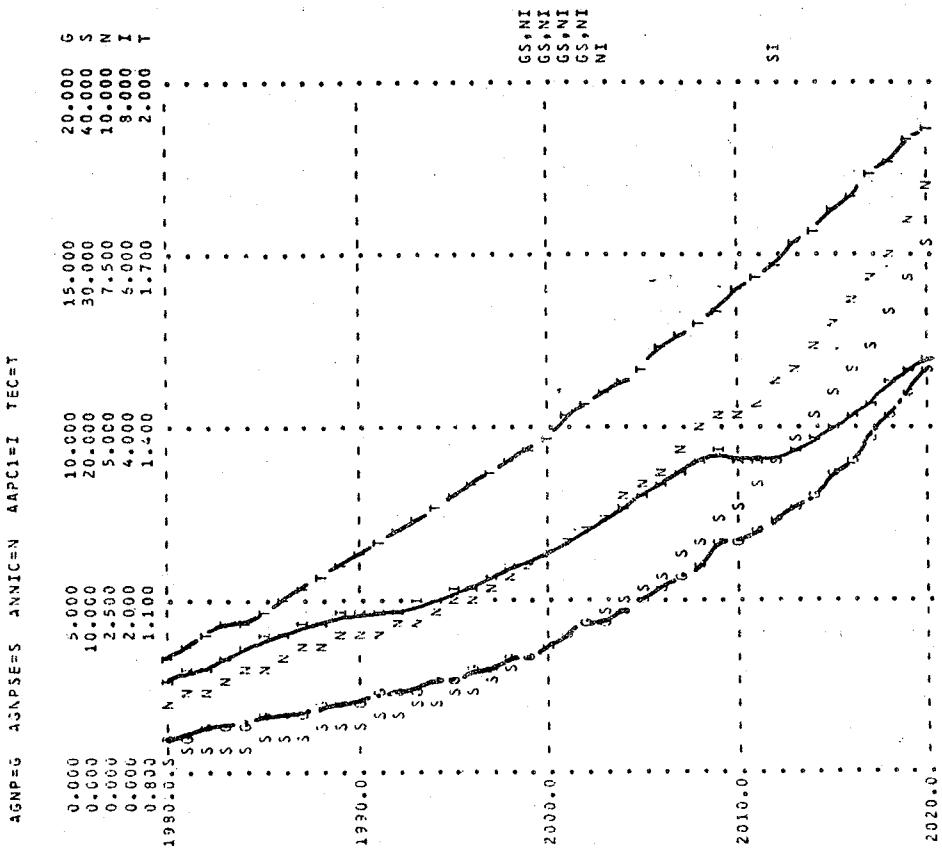


Fig.4. The result of Base run: the social output

The figure shows that at the year 2000, AGNP will reach the value of 3.71; AGNPSE 7.1; ANNIC 3.15; TEC 1.388; at the year 2020, AGNP = 11.52; AGNPSE = 30.73; ANNIC = 8.47; AAPCI = 2.54; TEC = 1.92. Obviously, the GNP of service sector AGNPSE grows faster than that of other sectors. According to the base run, AGNPSE

shares about 44.2% of AGNP at the year 2000; 53.1% of AGNP at the year 2020. It's worthwhile to note that neither AGNP nor APPCI reaches the value of 4.

To evaluate the behavior of the social system, it's not enough to see only the final output, we should also take the efficiency into consideration. Fig. 5 depicts some of the indexes reflecting the efficiency.

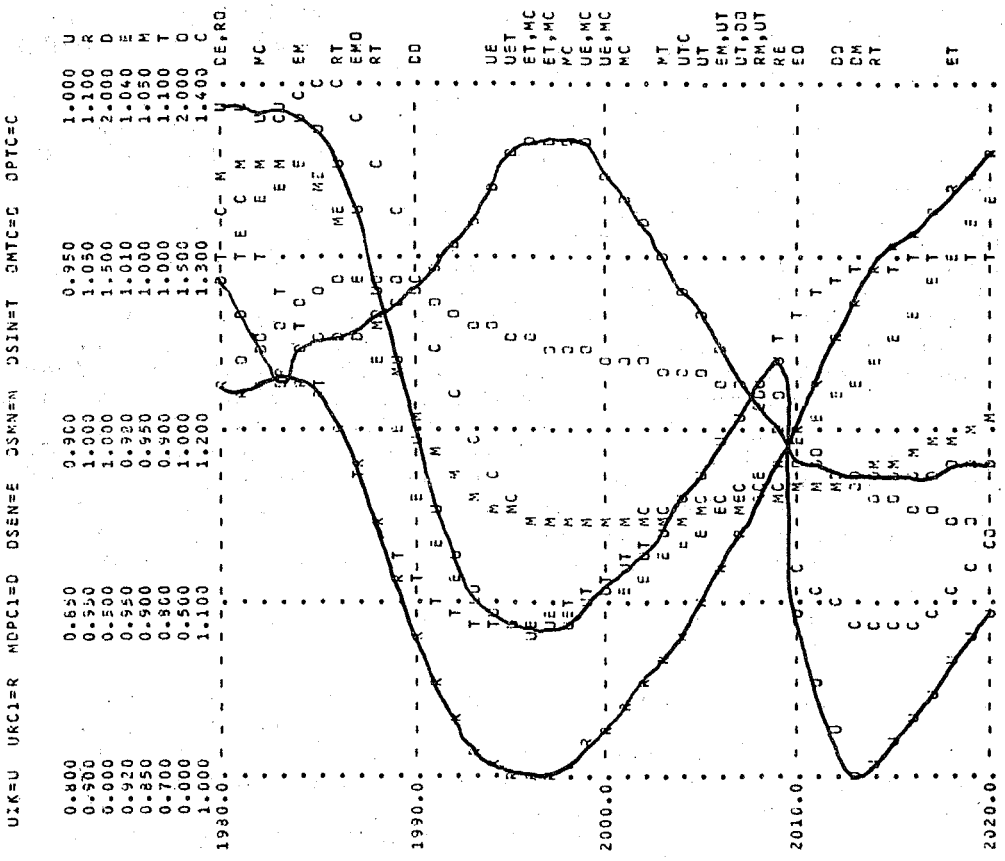


Fig.5. The result of Base run: the efficiency

The three blackened curves are: UIK, the synthetical capital

utilization; URCI, the efficiency coefficient determined by the production condition (energy, material, transportation availability); MDPCI, the efficiency coefficient determined by the market demand of the product. Other curves that have not been blackened are: the degree of satisfaction of energy needed (DSEN); the degree of satisfaction of material needed (DSMN); the degree of satisfaction of transportation needed (DSIN); the degree of overload of freight transportation (OMTC); the degree of overload of passenger transportation (OPTC).

From Fig. 5 we can find that the synthetical capital utilization UIK changes a great deal. As mentioned before, the systhetical capital utilization affected by three factors: the production condition factor URCI, the market demand factor MDPCI, and the social efficiency factor (which is not included here because it changes relatively moderate and the Fig. 5 is too crowded). Before the year 2019, the market demand factor MDPCI is greater than 1, therefore it does not set any real limits to the production. But during this period, the production condition factor URCI is less than 1, therefore UIK changes as URCI changes. URCI drops from about 1.02 in 1985 to 0.90 in 1990, which can be explained by the limited energy and material supply and too fast growth of industry production (before 1985, producdtion develops at a rate of 8%, but the energy supply develops only at a rate of about 6%). As mentioned in the model description section, the loop 2 will make the industry speed drop down, and at the same time, the development of technology and the discard of old equipment will reduce the energy consumption per unit of product. As a result, the URCI goes up again after 1997, while UIK follows its increasing. At the year of 2009, the market demand factor MDPCI drops down to 1 (which is the result of the industry development of other provices and the rising product cost of the big city). Then it begins to draw down the rising UIK: within 5 years, UIK drops from about 0.92 to 0.80, this means the production efficiency has suffered a great deal.

We can easily conclude from Fig. 5 that the limit factors to the growth of the city economy change with time. Before the end of the century, it is the production conditions which hinder the growth of economy while after 2010, it becomes the market demand factor. The figure shows us also the change of transportation overload: from 1989 on, the freight overload begins to go down, the passenger transportation goes down even earlier.

Policy Testing

As discussed in the above section, in the short run, the main factor which limits the economic growth of big city is production condition, including the degree of satisfation of energy,

material, and transportation. Now we want to see the effects of different policies on these problems. Both the final economic growth and efficiency should be taken into consideration.

The main policy tests made and their results are included in the following Table 1 (the variable SRGMP is for the ratio of service-made GNP to total GNP, the RNT represents the technical level of the industry capital ((K1+K2)/(K1+K2+K3+K4), see Fig.2), other variables have the same meaning as explained in the last section).

Test Name	Description	2001					2019					Worst UIK
		AGNP	AAPCI	TEC	SRGNP	RNT	AGN	AAPCI	TEC	SRGNP	RNT	
Base	Base-Run	3.95	2.65	1.41	0.44	0.78	10.85	4.68	1.89	0.60	0.83	0.80
1	More Investment to science and Tech.	3.97	2.67	1.43	0.44	0.78	11.51	5.33	2.07	0.58	0.83	0.82
2	More total capital Investment	4.41	2.81	1.44	0.47	0.79	12.63	5.26	1.94	0.61	0.83	0.82
3	Better energy and material supply	4.03	2.79	1.41	0.43	0.78	10.54	4.73	1.89	0.58	0.83	0.81
4	More investment to transportation	4.07	2.83	1.41	0.42	0.78	10.51	4.74	1.89	0.58	0.82	0.81
5	Higher capital discard rate	3.85	2.67	1.41	0.43	0.86	10.55	5.40	1.89	0.53	0.89	0.91
6	More investment to newly developing Industry	4.00	2.69	1.41	0.44	0.79	10.86	4.75	1.89	0.59	0.83	0.82
7	The collection of favorable conditions	5.00	3.23	1.45	0.47	0.80	13.79	5.75	2.05	0.61	0.84	0.87
8	The collection of unfavorable conditions	3.21	2.26	1.41	0.47	0.77	10.12	4.11	1.89	0.63	0.78	0.76

Table 1.Policy Testing and the Results

Now let us see some of the tests in the above Table 1.

Test 2: More capital investment.

In this test, the money invested by the state government, the loan made per year for capital investment, and the revenue retained by the municipal government are all doubled compared with that of the base run. This policy can raise the AGNP from 3:95 to 4.41 in the year 2001, from 10.85 to 12,63 in the year 2019. But the UIK does not change much (we can see this from Fig. 6), and SRGNP and RNT also have little changes. This means that, if the way to use the money does not change, by raising the money supply we can get a higher output value, but this does not necessarily mean we can release the tension of scarcity which we are suffering now, the efficiency is more likely to remain at the low level.

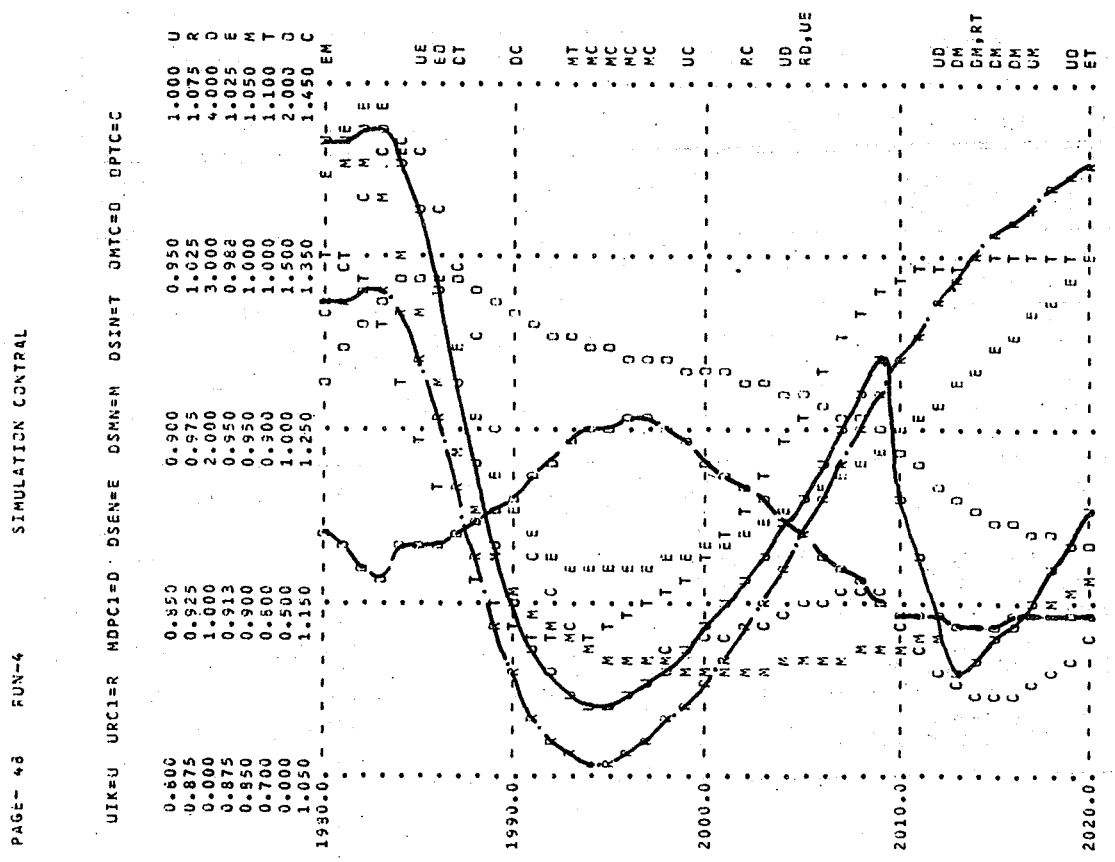


Fig. 6. The effects of more cepital investment (test2)

Test 3: Better energy and material supply.

In this test we suppose that the growth rate of energy and material supply upper limits are doubled, and with the price higher than that of the market, we can get 66% more material needed (compared with base run). Table 1 shows that the AGNP of the year 2001 has been raised from 3.95 to 4.03, and UIK, within this century, has been raised from 0.84 to 0.88, but after 2010 the UIK still remains at a low level (see Fig. 7). This does not surprise us, we have already known that the low UIK around the year 2010 is caused by market demand factor MDPCI, and the policy of this test has little effects on it. SRGNP, RNT do not change much either. The Test 4 shows a similiar results as above.

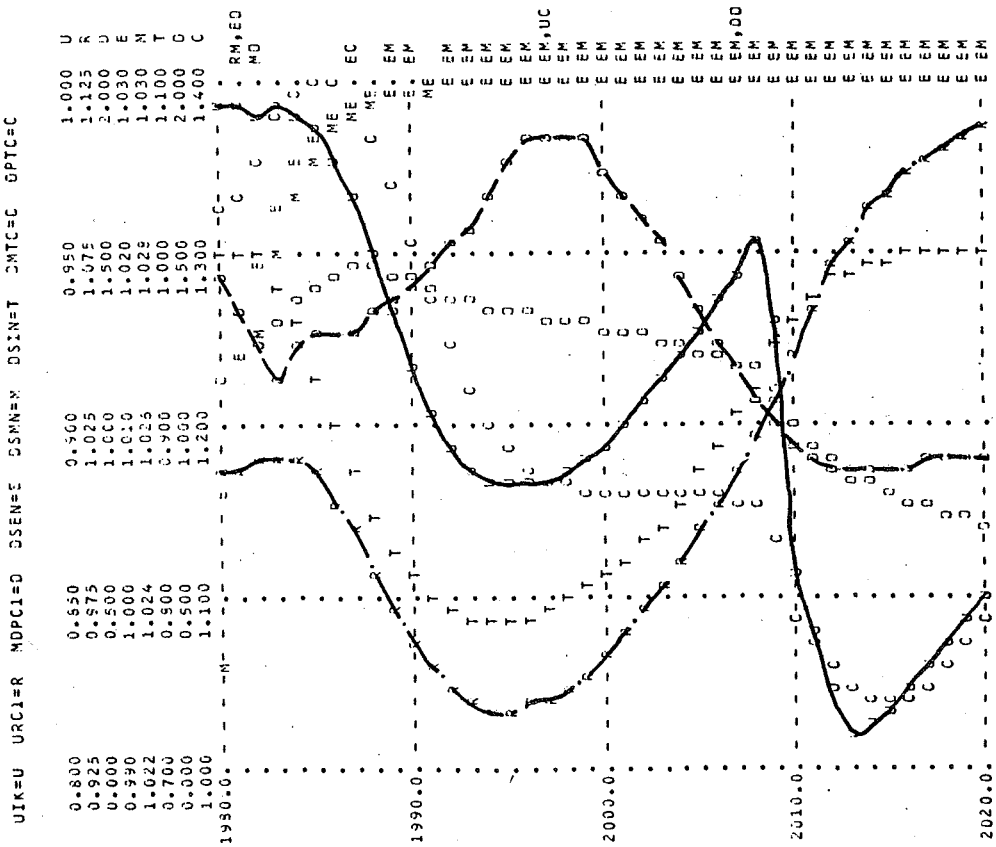


Fig. 7. The effects of the better energy and material supply (test3)

Test 5: Higher capital discard rate.

In this test, we raise the discard rate for K3 (see Fig. 2) from 1/20 to 1/10. This policy does not need any investment. It makes the AGNP drop down a little (see Table 1), but it raises UIK dramatically. For the first time, UIK does not drop around the year 2010, and the lowest UIK is 0.91 (see Fig. 8). This is owed to the higher RNT. By raising the discard rate, the old equipment will be thrown away, this will reduce the energy and material consumption of the production, and raise the quality of output. It has better effects on both the production condition factor URCI and market demand factor MDPCI. Its effcts last for a long time.

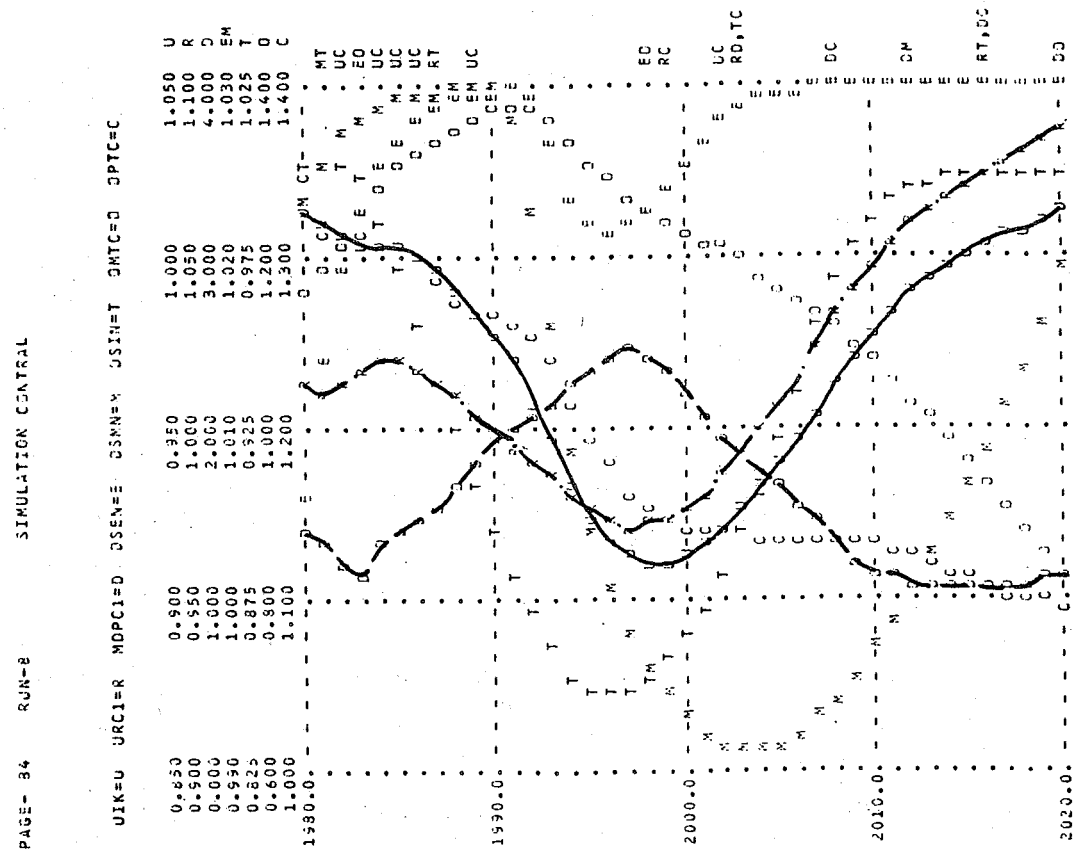


Fig.8. The effects of higher capital discard rate (test5)

Test 6: The collection of unfavorable conditions. In this test, we suppose the capital investment, the energy and material supply and the transportation investment are all unfavorable than that of the base run, to see how worse the situation could be. Compared with the base run, AGNP in 2001 drops 17% of that of base run, and the UIK remains less than 0.80 from 1993 until 2019. But the SRGNP is higher than that of the base run. The deterioration of the industry production condition reduces the GNP made by industry, as a result, SRGNP goes up.

CONCLUSION

In the above two sections we have analyzed the system's behavior and its response to different policies. According to these analysis, we can draw the following conclusions about the system:

1. From the viewpoint of the production capacity utilization, there are mainly two kinds of factors which limit the growth of the industry in big cities of China (and therefore limit the growth of the economy of these cities): the production condition factor, which is affected by the energy, material and transportation availability, and the market demand factor; which is determined by the cost and quality of the products and the economic growth of the other areas.

2. The production condition factor and market demand factor have different effects on the system at different time. Generally speaking, the production condition factor is the main limit factor before the end of the century, while the market demand factor is active after the early year of the next century.

3. More capital investment itself cannot really solve the problem. It may raise the total output of the system, but the efficiency may still be low.

4. Better material (energy) supply , or more transportation investment may release the tension caused by the production factor. But it has little effects on the market demand factor. The higher capital discard rate has effects on both of the two factors. And it can make contribution to the social efficiency both in the short run and the long run, while it may depress the total output a little.

5. Without the proper adjustment, the economy of the big city may suffer more the resource scarcity in the future. As the resource supply becomes worse and worse, at the end of this century the output of the city may drop as much as 17%, compared with the normal situation.

6. Therefore we recommend that the municipal government of the big city to make some efforts to increase the resource supply, especially in the recent years, while to speed up the capital discard rate is another good adjustment.

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