A SYSTEM DYNAMICS MODEL
FOR ECONOMIC DEVELOPMENT OF OLD INDUSTRIAL CITIES

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ABSTRACT

This paper discusses the modeling problem for the economic development of the old industrial cities in China.A system dynamics model is applied to analyse the recessionary causes of the old industrial cities,and find the possible strategies of the technical progress and economic development in future. The paper gives the simulation results of an example,and discusses the system structure with adding policy loops in the causal diagram.

INTRODUCTION

The economy of some industrial cities in China during the 1950s had got rapid growth, but in recent years the difficulty has risen, it is that the recession of the industrial production, the overstock of the products and the decline of the economic results.

Because China is a developing country with the numerous population,the pressure to the employment is very large. It is impossible to carry out the policy migrating population on a large-scale. In order to support the numerous population, these cities only depend on the further growth of their own economy. Therefore, it is necessary to analyse the causes of the industrial recession,find the channel of promoting economy and formulate the strategies of the future development about the old industrial cities.

This paper studies the economic development problem of the old industrial cities in China using the qualitative and quantitative approach of system dynamics, discusses the modeling problem of the system structure with adding policy loops in the causal diagram.

CAUSAL ANALYSIS

The city is a typical complex system. The social, economic and technological factors are interrelated closely. The inside structure and outside environment of the city vary over time. Especially, improving an old urban system is still more difficult than building a new urban system.

The developed process of the old industrial cities in China has following character:

1) The industrial structure of the cities mostly took the energy-consuming traditional industry as the leading industry,it resulted in the shortage of the energy source and the pollution of the urban environment.

2) The development of the cities pursued the industrial growth one-sidely,and neglected the coordinated development of the third industry.

3) The population of the cities increased excessively, the quantity of the workforce is numerous but their cultural quality is lower, therefore the pressure to the employment is very large.

4) The cities was closed to the outside world in the long term, there is a big gap between the technical competence of these cities and the foreign advanced level.

In order to find the root causes of the economic decline of the old industrial cities, the causal relation among natural resources, population, technology and industrial economy are discussed as follows.

1.The Causal Relation of Resource and Economy

The economy of the old industrial cities in China usually developed on the basis of the population and the natural resources. The growth of the urban industry was restrained by the energy source, especially restricted by the electric power.

On account of the technological and managemental causes, on an average, the energy-consuming of unit product is one-two times larger than that one of the industrial advanced countries.

Owing to the shortage of the energy supply, the production capacity of the urban industry can not be utilized fully, thus it affects the profit and the revenue. From the above mentioned, energy shortage → operation ratio → output value → prafit → revenue → investment → production capacity → energy demand which are connected in a causal loop, but also it is a vicious circle, see Figure 1.
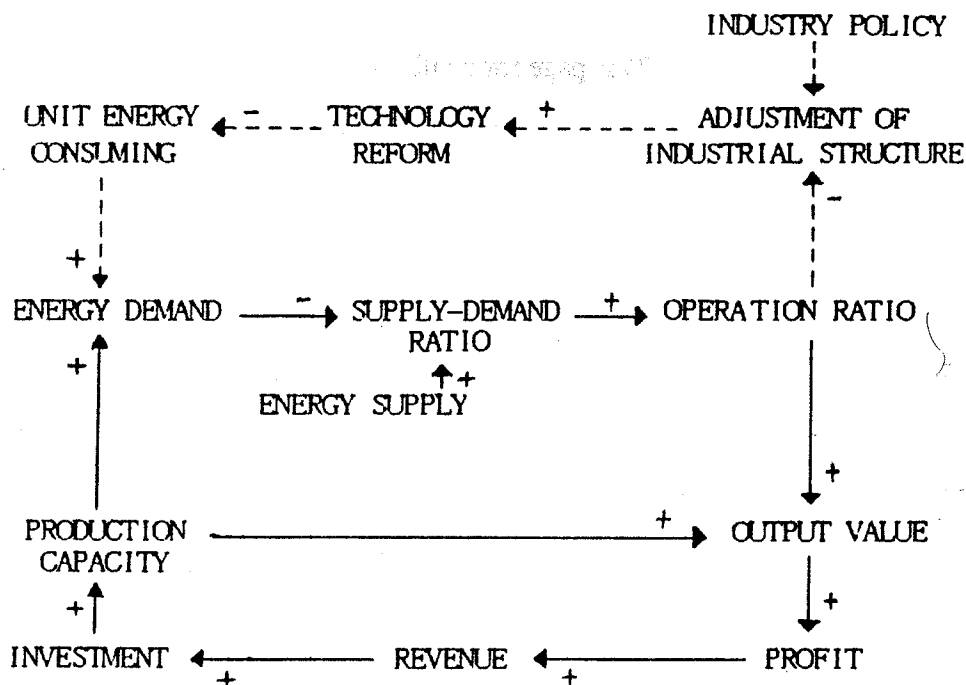

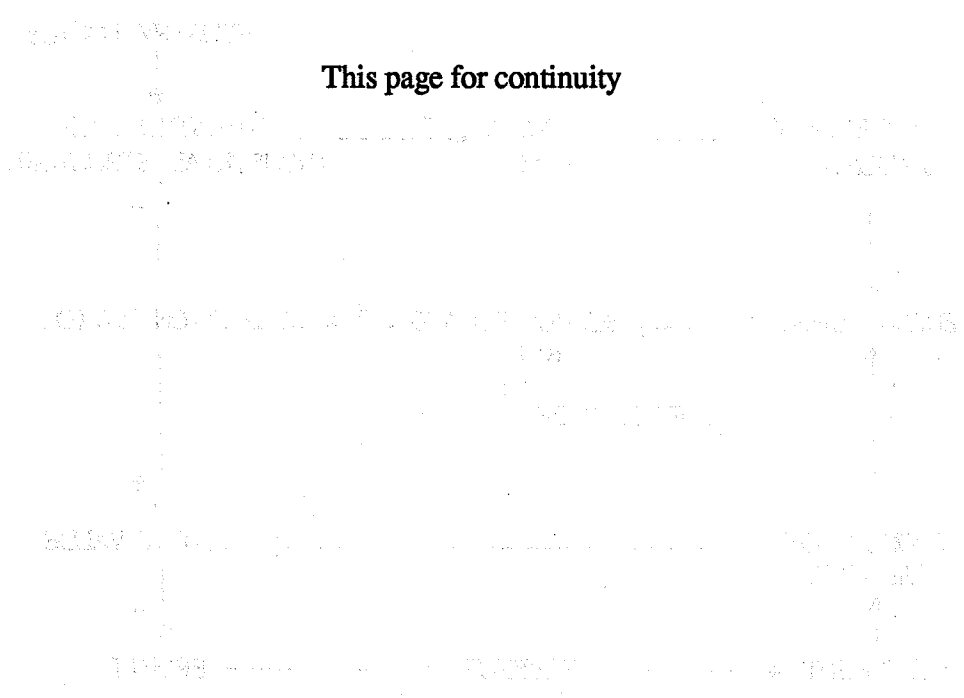Figure 1.   The causal diagram of energy and economy

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In order to extricate the cities from a difficult position, it is necessary to make the industry policy correctly, and transform the industry from a resource-dense type to a technology-dense type through adjusting the industrial structure and reforming the traditional industry. On the one hand it can reduce the energy-consuming of the unit product, on the other hand it can raise the production capacity. As a consequence, the economy system of the old industrial cities will come to the track of a good circle through adding a policy feedback loop in Figure 1.

2. The Causal Relation of Population and Economy

The population of the old industrial cities in China has increased excessively, the workforce source is rich but can not flowed, therefore the pressure to the employment is tremendous.

In the past, the production function of the cities was emphasized one-sidely, and the service function of the cities was neglected, the third industry could not obtained the coordinated development. People focused the employment on a few industrial departments, it results in a decline in the labour productivity, see Figure 2.
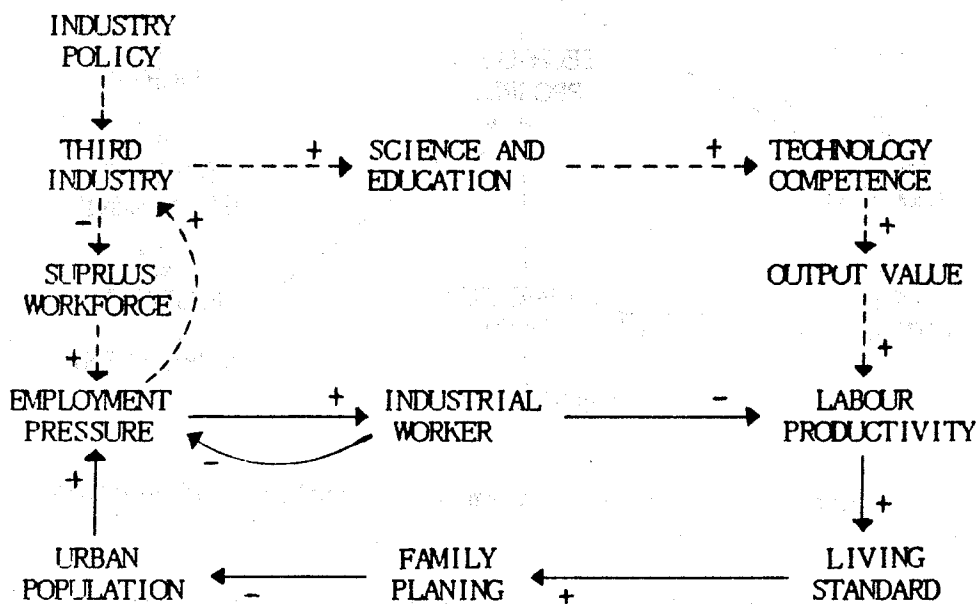
Figure 2. the causal diagram of population and economy

In order to transform the unfavourable situation of the workforce employment, it is necessary to adjust the industry policy and develop the third industry. The third industry can attract a great quantity of the surplus workforce, thus reduce the pressure to the employment. In all respect, it is possible to spur the technology progress, raise the labour productivity, improve the living standard of the urban people, strengthen the family planning and control the excessive increase of the urban population.

3. The Causal Relation of Technology and Economy

Why the products overstocked in the old industrial cities? A direct cause is that the products can not meet the needs of the domestic and overseas market. This is because these cities was in a closed situation from the outside world in the long term, the technology and management of the industrial production full behind, see Figure 3.
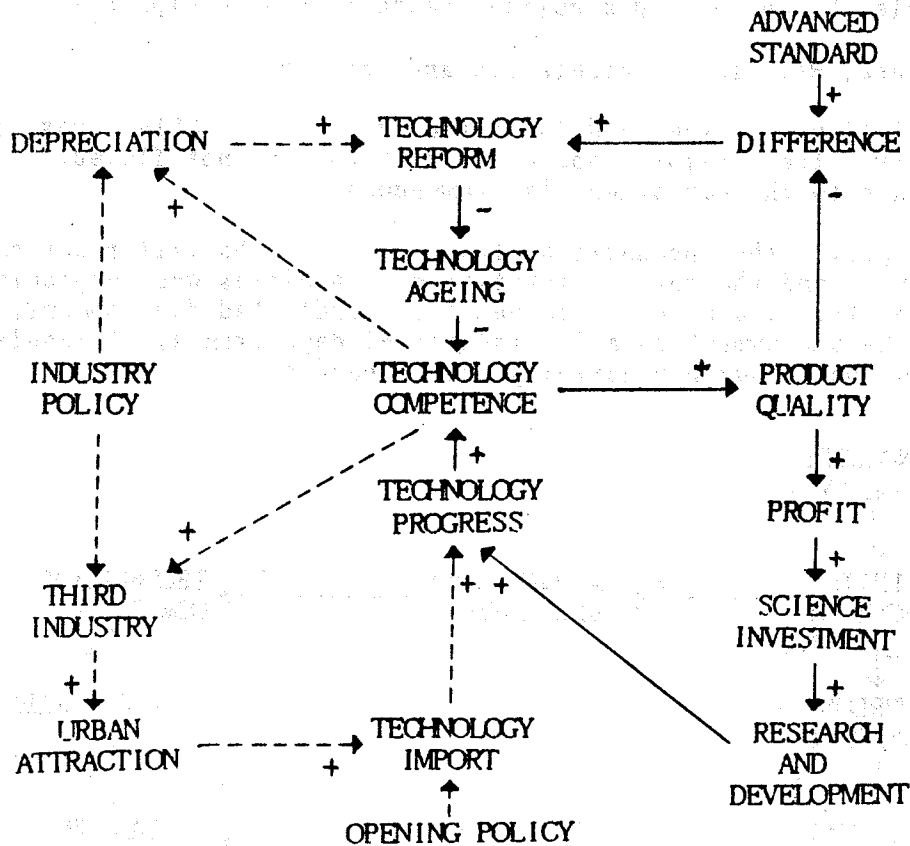
Figure 3.The causal duagram of technology and economy

In order to guarantee the steady increase of the economy in the old industrial cities, it is necessary to resolve the technology aging problem at the root, organize the production according to the international advanced standard, persist in the policy of opening to the outside world, import the advanced technology and modern management, speed up the technology reform to the traditional industry, finally the economy and technology can develop in a coordinated fashion.

SYSTEM MODELING

1. Modeling Purpose

In this paper, we select the S city to be a typical example to construct an urban system dynamics model. The purpose is to test the results of the

selected policies and provid the scientific basis for formulating the strategies of the economic development in a kind of the old industrial cities.

2. Model Framework

The model consists of four modules: economy, resource, population and technology.Its framework is described in Figure 4. We complete the task of the modeling and simulation for above-mentioned model under the help of the system dynamics modeling support system (Pei 1990).
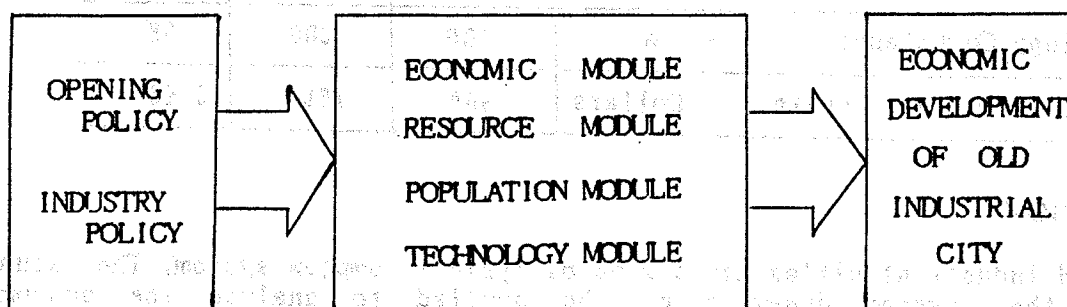

Figure 4.   The framework of urban model

3. Simulation Results

There are two experimental projects for urban development on the basis of the difference of selected policies. First project(No.1) is a basic run mode, corresponding to the closed pattern of the old industrial city, its simulation results are represented in Table 1. Second project (No.2) is a new run mode, corresponding to the opening pattern of the city, its simulation results are represented in Table 2.

In comparison with project No.2, project No.1 shows that the economy and technology of the city will obtain faster growth,it is a result of opening policy and industry policy for the structure adjustment.

Table 1. Simulatiom results of project No.1

		1990	2000	2010
Urban Population	10E6 Person	570	623·7	682·4
Gross National Product	10E8 Yuan	190·8	389·6	879·5
Industrial Output Value	10E8 Yuan	241·1	472·2	1160
Output of Third Industry	10E8 Yuan	70	158·8	357·3
Technology Competence	%	100	166·5	314·4
National Income per Capita	Dollars	569	1062	2191

Table 2.Simulation results of project No.2

		1990	2000	2010
Urban Population	10E6 Person	570	611.3	655.7
Gross National Product	10E8 Yuan	190.8	561.4	1446
Industrial Output Value	10E8 Yuan	241.1	625.4	1754
Output of Third Industry	10E8 Yuan	70	252.6	792
Technology Competence	%	100	200	438
Natioal Income per Capita	Dollars	569	1561	3748

CONCLUSIONS

The old industrial cities are a kind of typical complex system. The study shows that system dynamics can be applied to analyse the economy development problem of the old urban system. In order to improve the behavior characteristic of the old urban system, it is necessary to carry out the policy of opening to the outside world and adjust the industry structure. Therefore, adding policy loops in the causal diagram is requisite. The non-equilibrium behavior of the opening urban system will remain to be studied further.

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