THE DYNAMIC RELATIONSHIP BETWEEN TRANSPORTATION AND OTHER INDUSTRIES IN CHINA

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ABSTRACT

This paper analyses the dynamic relationship between transportation and other industries with system dynamics theory and method. We develop a system dynamics model to protray how the transportability influences other indistries, and have made some computer simulation in which we simulated the dynamic characteristics of the system at different alternatives of investment.

In the simulation, we properly reduced the investment in heavy industry and increase the investment in transportation, while the total amount of the investment is the same. The output value of heavy industry didn't decrease, on the contrary, it increased. At the same time, the output value of other industries and national income increased too. This indicates that the transportability directly influences the outpput value of other industries.

From the simulation result we also see that the investment in transportation of China is too small and this leads to the situation that the development of transportation can't meet the demand of national economics in China.

This paper is a application example of how system dynamics is used to solve problems of social economics. This research will help people to know the importance of transportation in national economics and government to make policies.

1. PROBLEM AND PURPOSE

Transportation is a major one basis of national economic. It's very important in linking production circulation and distribution as well.

For nearly fourty yrars, transportation in China has developed quickly. However it doesn't meet the demand of industrial and agricultural production and people's life. For a long time transpotation in China is in a passive state, to which economic development is subject.

There are a lot of objective causes for the passive state of transportation in China. But wrong decisions caused by subjective element are primary. That is, strategy position and precursory affect of transportation were not fully realised, systematic and quantitative analysis are seldom used to study the relationship between transportation and other industries. Therefore the alternative of investment didn't include improving the transportation first. And it was even neglected. Especially during the period of fifth and sixth five-year economic plan, the investment in transportation of China is not sufficient at all . Other policies for developing transportation are not adequate also.

According to the fundamental concept of system engineering—the concept of system and using system dynamics methods,we put transportat-

ion into the whole national economic system. From macroscopic view we initially researched something as following:

The dynamic relationship between transportation and other industries; The concrete influence of transportability on other industries; The speed at which development of transportation can meet the demand of other industries. The influences of different alternatives of investment on other industries and whole national economic; etc.
Our purpose is to describe the importance of transportation deeply. So as to advise goverment to give an adequate percentage of total investment to transportation, give priority to transportation really, and change the passive state of transportation quickly.

2. ANALYSIS OF THE CAUSAL LOOPS

The relationship between transportation and national economics is reflected by that between transportation and other industries. Heavy industry, light industry, agriculture, commerce and the building industry are contained in this paper. The main relationship between transportation industry and other industries is that transportation industry gives transportation for them, raw materials required by industry, agriculture and the building industry must be transported from supplying places to users, and on the other hand the products of industry and agriculture must be transported to consumers. If transportability does not meet demands,production sectors will not gain enough raw materials, and this will directly influence production, causing the output value of production to decrease. Meanwhile, the products of industry and agriculture cannot be sold out in time. And the funds for production cannot return in due time, as a result, production of other sectors will be affected. Supply and marketing of cimmerce depends more on transportability. If transportability can't meet demand, circulation of goods will be hindered. Purchase and sale will be limited, and in the long run, the output value of commercial will be affected.

The demand of every sector for transportability relates to it's production. Namely it relates to fixed asset. As for industry, agriculture and the building industry,the more fixed asset they have, the more production equipment is possessed;The more production equipment is possessed, the more the productivity is; The more productivity is, the more raw materials are needed and the more products are produced, and so the more transportability is demanded. In commerce if much fixed asset is possessed, namely much business capital are possessed and business ability, the demanded transpotability will be great.

In China the fixed asset of each sector depends on national investment. The more money is invested by government, the more fixed asset is possessed by sectors. The investment is got from the national income. Therefore, investment relates to national income. The production equipment will be worn away and olden.So there is a certain rate of depreciation. In fact, the depreciation of equipment is the depreciation of fixed asset.
The transportability depends on the fixed asset of transportation. The causal relationship between them is positive.

In summery, the causal relations are shown in Figure 1.

3. ANALYSIS OF THE MODEL CONSTRUCTION

In this paper fixed asset of every sector is a accumulative quantity which increases with time. At the same time, It is a basic variable which determines output of the sector and transportability demanded by the sector. Therefore we define the fixed asset of every sector as level variables. In this system there are six level variables. They are six kinds of fixed asset of heavy industry, light industry, agriculture, building industry, commerce and transportation.

The rise rate of fixed asset is a corresponding inflow rate. Because a certain part of national income is put in the accumulation each year, and a certain part of accumulation is taken as fixed asset, the fixed asset rises gradually. Another part of accumulation is taken as liquid assets. The ratio among them can be found in "Yearbook of China statistics". According to the requirement of improving the living standards of people the rate of accumulation will be only on the medium or low level of the past. And after the national income increases to a certain degree, the rate of asset accumulation must be reduced and the rate of consume should be improved so as to make people's living standard rise rapidly. The rate of depreciation of fixed asset is the corresponding output rate. There is a delay of time between investing and forming of available fixed asset.
The relation between the output value and the fixed asset of every sector can be represented by capital-output rate. Calculating the capital-output rate, we must consider the impact of progress of science and technique, improvement of management skill, reform of system organization and transportation status on capital-output rate. So we introduced the science and technique coefficient and transportation impact coefficient, etc. They are both nonlinear functions, and represented approximately by TABLE function and CLIP function respectively.

The national income is formed by net output value of every sector. National income by per unit output value can be calculated according to the data of"Yearbook of China statistics". Providing the limited space, the detail flow diagram is neglected. Here we simply represent the structure of flow chart in Figure 2.

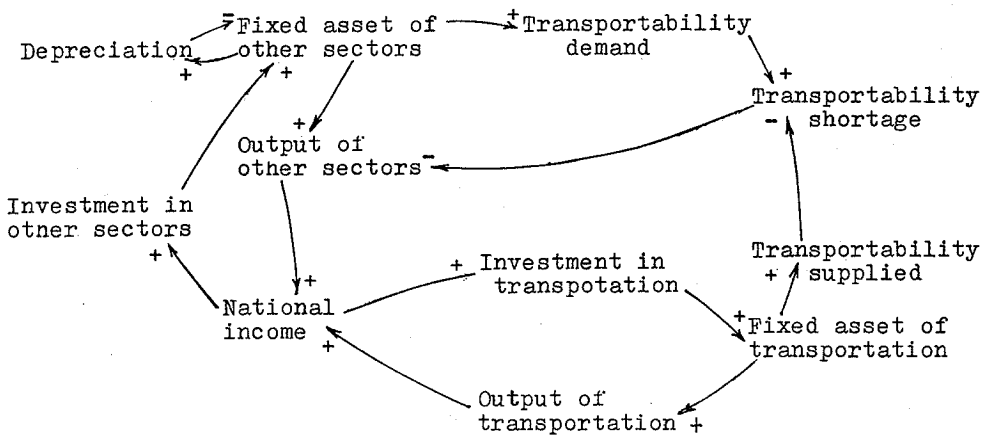
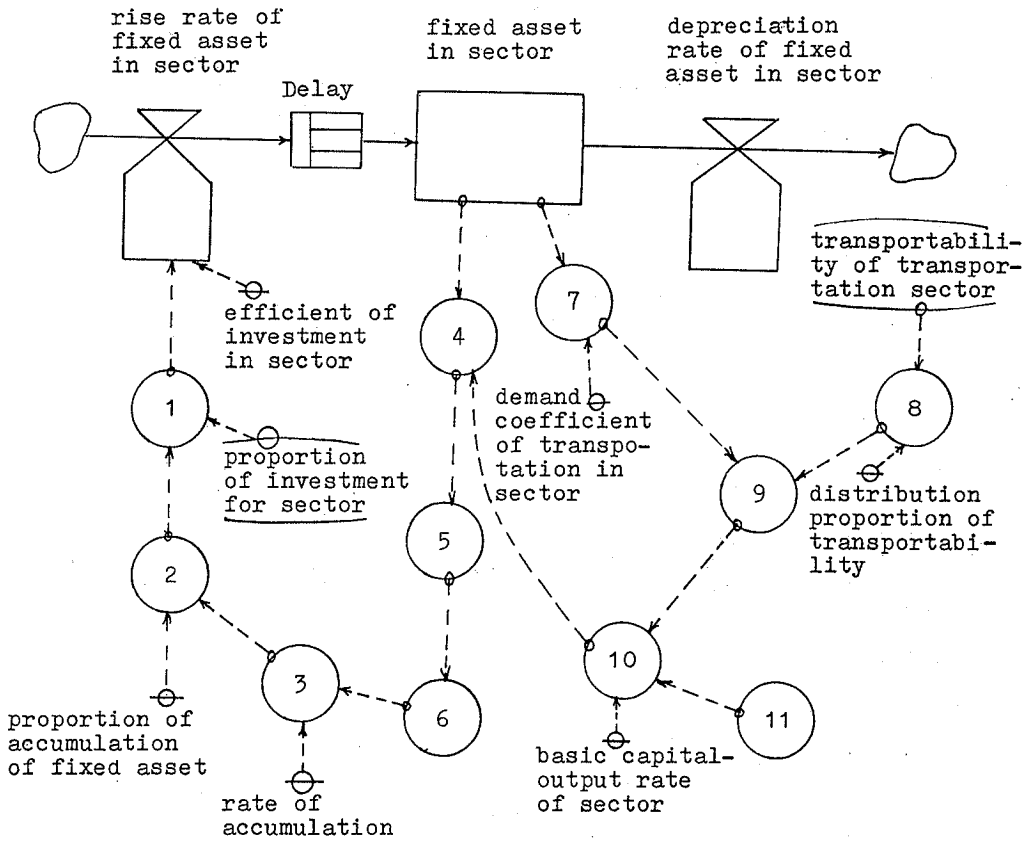


Figure 1. The simplified causal loops of the system



1. investment of fixed asset in sector
2. investment for fixed asset
3. accumulation
4. output of sector
5. net output of sector
6. national income
7. demand of transportability in sector
8. supply of transportability for sector
9. impact of transportation
10. capotal-output rate in sector
11. impact of science technique and management

Figure 2. simply structury of flow chart

4. MODEL RUN AND SIMULATION RESULTS

Dynamo program of this system is run on IBM PC/XT computer. Initial value of the level variables are data of the year 1982 in"Yearbook of China statistics". The simulation time is from 1982 to 2000. The simulation time interval is one year (namely DT=1). The simulation results includies:

(1) Tabulation and Diagram of every sector's fixed asset which changes with time.

(2) Tabulation and Diagram of every sector's output value which changes with time.

(3)Tabulation and Diagram of every sector's transportation impact coefficient which changes with time.

(4) Tabulation and Diagram of transportability which changes with time

(5) Tabulation and Diagram of national income which changes with time

To research investment's impact on transportability and it's impact on other sector caused by the above, we use three different alternatives of investment to make policy simulation. In each case, the five variabls described above which changes with time are calculated. Because of limited space, DYNAMO Program and the whole simulation results are not shown here. We show the major results below in Tables 1,2,3 and Figure 3,4,5,6,7,8.

Alternative 1

Proportion of investment in every sector is:

Heavy Industry:	57%	Light Industry:	14%
Agriculture:	3.5%	Building:	2.3%
Commerce:	6.5%	Transportation:	16.7%

The Simulation results of Alternative 1 are shown in Table 1 and Figure 3,4.

Alternative 2

Proportion of investment in every sector is:

Heavy Industry:	55.7%	Light Industry:	14%
Agriculture:	3.5%	Building:	2.3%
Commerce:	6.5%	Transportation:	18%

The simulation results of alternative 2 are shown in Table 2 and Figure 5,6.

Alternative 3

Proportion of investment in every sector is:

Heavy Industry:	59.7%	Light Industry:	14%
Agriculture:	3.5%	Building:	2.3%
Commerce:	6.5%	Transportation:	14%

The simulation results of Alternative 3 are shown in Table 3 and Figure 7,8.

Table 1

	Fixed asset in year 2000 (100 million Yuan)	Output value in year 2000 (100 million Yuan)	Times of output larger than year 1980	Output value growth rate per year
Heavy Industry	10700.0	14900.0	5.76	9.15%
Light Industry	3451.8	15916.0	6.89	10.13%
Agriculture	934.6	15560.0	7.14	10.33%
Building	657.49	4603.1	6.00	9.37%
Commerce	1865.9	2963.5	6.74	10.01%
Transportation	3584.4	1595.8	6.46	9.78%
National income	26054 (100 million Yuan) (in year 2000)		7.06 (times than 1980)	10.27% (growth rate)

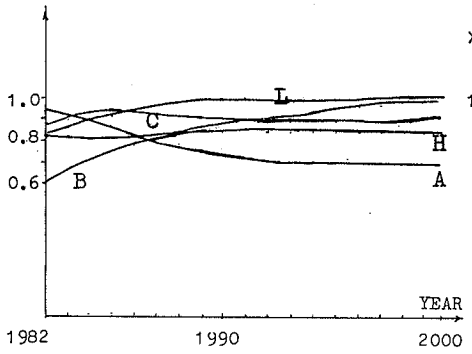


Figure 3

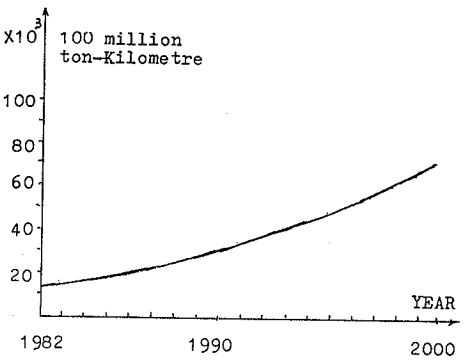


Figure 4

Table 2

	Fixed asset in year 2000 (100 million Yuan)	Output value in year 2000 (100 million Yuan)	Times of output larger than year 1980	Output value growth rate per year
Heavy Industry	11000.0	16900.0	6.53	9.84%
Light Industry	3639.2	16780.0	7.27	10.42%
Agriculture	994.5	17602.0	8.07	11.00%
Building	693.8	4962.1	6.47	9.78%
Commerce	1983.4	3352.5	7.62	10.69%
Transportation	4054.8	1805.2	7.31	10.46%
National income	28864 (100 million Yuan) (in year 2000)		7.83 (times than 1980)	10.83% (growth rate)

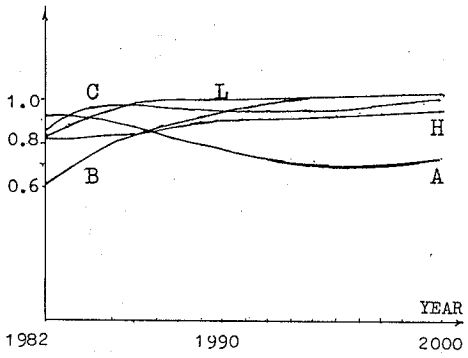


Figure 5

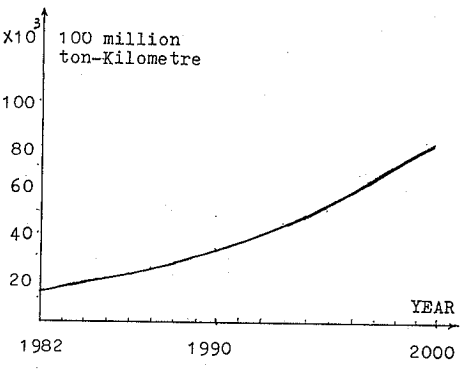


Figure 6

Table 3

	Fixed asset in year 2000 (100 million Yuan)	Output value in year 2000 (100 million Yuan)	Times of output larger than year 1980	Output value growth rate per year
Heavy Industry	9700.0	10900.0	4.21	7.45%
Light Industry	2959.9	11669.0	5.05	8.44%
Agriculture	796.8	11388.0	5.22	8.62%
Building	564.35	3368.9	4.39	7.68%
Commerce	1595.3	2168.9	4.93	8.30%
Transportation	2623.3	1167.9	4.73	8.08%
National income	19077 (100 million Yuan) (in year 2000)		5.17 (times than 1980)	8.56% (growth rate)

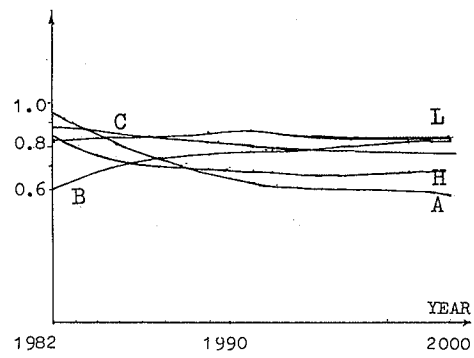


Figure 7

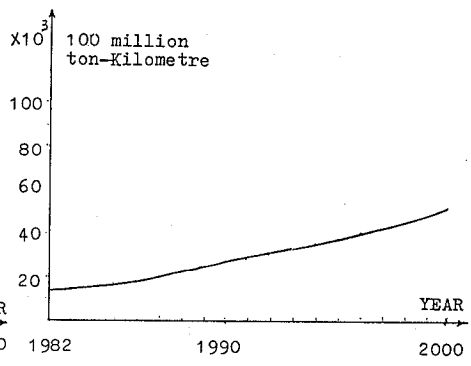


Figure 8

Figure 3, Figure 5 and Figure 7 represnnt transportation impact coefficients changes weth time.
in the Figure: H—Heavy industry L—Light industry
A—Agricultury B—Building
C—Commerce
Figue 4, Figure 6 and Figure 8 represent transportability changes with time

5. ANALYSIS AND CONCLUSIONS

(1) Transportation relates closely to other industries. The speed of growth of transportability directly impacts on capital-output rate of each industry⟶impacts on output value⟶impacts on national income⟶impacts on total investment⟶impacts on fixed asset⟶impacts on output again. This is a positive feedback relation. But given certain transportability, transportation's impact on the production is negtive. So we should give priority to develop transportation. Let it become an active element which helps to promote industrial and agricultural production.

(2) Proportion of investment in transportation directly influences the growth of transportability. Comparing the three alternatives above, we can see while the total amount of the investment is the same, if we appropriately reduce the investment in heavy industry and increase the investment in transportation, the output value of heavy industry will not decrease, on the contrary, it will increase. Meanwhile, the output of other industries and national income will increase too, and their increase will be faster.

(3) For a long time the investment in transportation in China are quite small. Except the period of fourth five-year economic plan. It corresponds to the alternative three. In this case, the transportation impact coefficients are less than 1. It means supply is less than demand. It's the reason why transportation is in a passive state. We suggest in the future the investment in transportation will not be less than 16.7%. We'd better keep the highest level of the past for the future, namely 18%. This is the alternative two. Such and such, after the year of 2000 transportation will basically meet the demand of national economics in China.

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