A SYSTEM DYNAMICS APPROACH TO THE FUNCTION
OF THE ECONOMIC LEVERAGES IN CHINA'S ECONOMY

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ABSTRACT

After being overlooked for many years, now the financial and monetary
system plays an important role of adjustment and control functions in
national economy, relating to which, the four economic leverages--
price, tax rate, interest rate and wage are the main tools   of
carrying out these functions. Based on system   dynamics   approach,
this paper quantitatively studies the long-term development tendency
of their interaction and coordination. Based on simulating results
under normal economy development, policy tests and analyses have been
done to discuss the problems emerging from current economic reform.
The reasonable ranges of the adjustment of price, tax rate, interest
rate and wage increase rate are suggested and the amount of money
supply are discussed. Then some policies of coordinately applying the
leverages to improve the behaviors of system are put   forward. This
paper has made some progress in quantitatively analysing the long-term
development of the financial and monetary system, in establishing a
credible and practical model for policy analysis to solve the problems
emerging from the economy of China.

INTRODUCTION

China's financial and monetary system is the key of national economy.
Its   adjustment   and   control   functions have been   more and more
outstanding with the economic development of China. Economic leverages
are important tools to carry out these functions. Up to now, many
works have been done to study the functions of the economic leverages
in China's economy, but almost all of them are qualitative or static
in some areas. What relating to these problems most are quantitative,
and they effect each other dynamically. So it is urgent to have a
systematic and quantitative study. Based on system dynamics approach,
this paper study the adjustment and control functions of the main
economic leverages--price, tax rate, interest rate and wage, and to
discuss the long-term development tendency of their interaction and
coordination. This paper also discuss the relationship between money
supply and economic leverages and the problem of reasonable money
supply.

System dynamics is a structure--function simulation. System dynamics
model could be a laboratory for policy test. By tests of changing

structure and parameters of system model, we can find out the way to improve the behavior of the system.

THE ASSUMPTIONS OF THE MODEL

A model is a abstraction or simplified description of real system. For the purpose of the study, this model make the following assumptions to the complex system:

1. The average tax rate is taken. Tax rate are varied in the kinds of tax rate, the amount of tax rate, the period of paying tax, etc. The average tax rate is a weighted average of weighting the amount of every tax rate.

2. The average interest rate and the average loan rate are taken.

3. The average wage, or wage per capita per year, is taken to show the average level of wage and wage growth rate in macroeconomy.

4. The four price indexes--industrial, agricultural, business and consumption product are taken to mainly reflect change of price in price system. The price indexes of the model are set 100 in the initial year 1975.

5. The increase of money supply only concerns the increase of national income and the structural price. The influence by changing the speed of money circulation and others to the rate of money supply is overlooked to simplify the model.

THE DESCRIPTION OF THE MODEL

In order to clearly describe the four economic leverages, the model is divided into four sectors. Figure 1 shows the main causal feedback loop of the cooperation of the four sectors.

The main loop A, B and E are positive feedback loops. The main loop C and D are negative feedback loops. The positive feedback A and B cooperate with the system environment to make price, wage and capital stock increase exponentially. The result of interaction of the positive feedback loop E bank sector and wage subsystem is overshooting in the behavior of interest rate. While total deposit in bank is increased, the scope of investment is further controlled and profit rate decrease gradually with the development of economy, interest rate will decrease after reaching its peak value. The negative feedback C interacts on wage sector and bank sector to reduce the pressure on loan growth rate by decreasing investment shortage gradually. Investment shortage is one of the main cause of overshooting in the behavior of loan rate. The negative feedback loop D reflect the cooperation of interest rate and price, which restrict price and interest rate to increase forever in exponential way.

There are 350 equations in the model. For the problem of money supply, the amount of money supply is determined by:

```
A    MS.K=(1+RPROD.K)(1+RPI.K)*SMS.K+ME.K
L    SMS.K=SMS.J+DT*(RSMS.JK-SMS.J)
N    SMS=182.5E8
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R    RSMS.KL=MS.K
A    RPI.K=(RIPI.K+RAPI.K+RBPI.K+RCPI.K)/4
A    RMS.K=(MS.K-SMS.K)/SMS.K
```
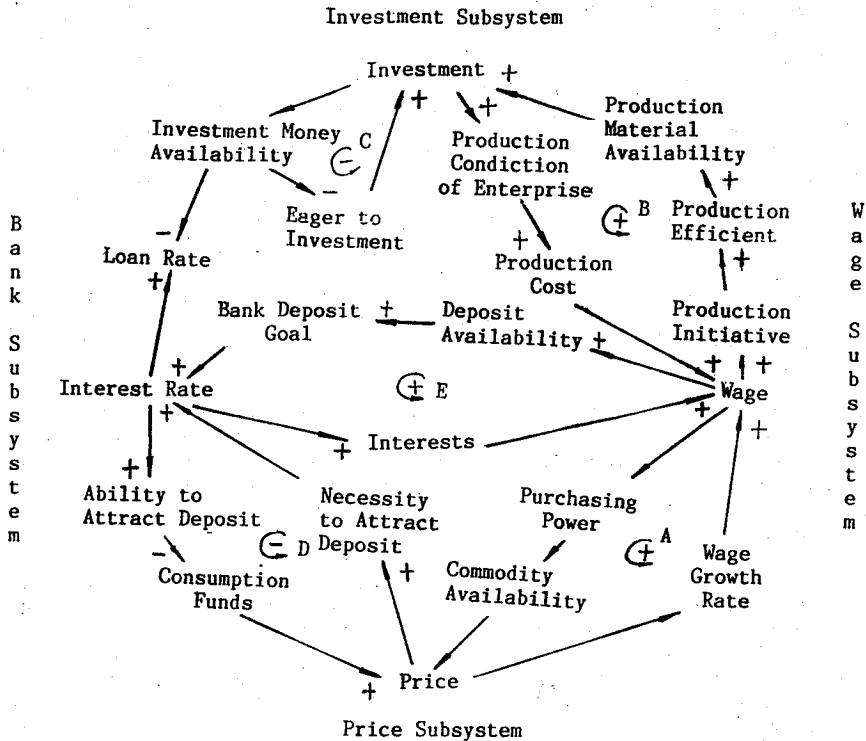

Figure 1. The main causal loop of the model

where
    MS--Amount of money supply
    ME--Exceeding amount of reasonable money supply
    SMS--Smooth money supply
    RMS--Money supply increase rate
    RPROD--Economic growth rate
    RPI--Average price growth rate

The reasonable increase rate of money supply is the product of economic growth rate and structural or planned price growth rate. If actual increase of money supply exceed the reasonable one, it will cause demand of society to expand and supply to be not sufficient, then price will rise.

BASE RUN AND ITS ANALYSIS

The simulation period is 50 years, from 1975 to 2025. The base run results are shown in Figure 2 and 3.

It is shown in Figure 2, increase rate of national income fluctuates slightly. Its average level is 7% and will decrease to 6% after about 2005. Accumulation rate decreases gradually, it is over 30% in the initial period of economic development (from 1975 to 2000) and it decreases to 25% after 2000.

Interest rate and loan rate are shown as overshooting in Figure 3. The reason in structure has been analysed before. The simulating result show the tendency and scope of their behavior. The interest rate and loan rate are shown as an exponential growth from 1978. The interest rate growth reaches its peak in about 1995, and the loan rate about 1996 after one year delay. After 2005 the interest rate is almost stable at 10% and the loan rate is 14%. The higher the interest rate,the bigger the loan rate, but the loan rate is limited to grow because enterprise can't invest for capital cost that exceeds its burden. The interest rate growth is too slow these years. · There are two main disadvantage by analyzing the simulation results:

a. Interest rate should be related to price change. If price rise too fast, it's better to raise interest rate correspondingly to attract deposit, which will slow much amount of money in hands of residents to rush to market.

b. Loan rate is stable at too low level. It worsen the "investment thirsty" specialized in shortage of economy in developing countries and cause society demand or investment demand in particular to expand without planning. Then total demand and supply of society are not balance in growth, which will bring about great difficulty to develop the whole economy.

The tax rate behavior is a S-shape growth. Because there are two main loops in its structure, one is positive and another is negative. At the beginning of simulation, the dominate loop is the positive feedback loop. The tax rate is shown as an exponential growth. In the later period of simulation (after 2000), the dominate loop is the negative feedback loop, which mainly determine the tax growth rate to decrease gradually. The increase tendency of the tax rate is stable at about 25%. Tax rate is related to enterprise profit and efficiency and other indexes. It is limited to grow. The generally stable tax rate policy should be taken to increase the national income in whole developing enterprise production. Then economy will grow continually.

The growth tendency of wage is also in approximately exponential way. The wage growth rate increase more rapidly in the first period of economic development because of the smaller initial wage and will become less than 3% after 1990. Actual wage growth rate is equal to wage growth rate minus price growth rate, which reflects the actual income of workers. During the whole simulation time, the average wage growth rate is 3%, and the average national income growth rate is 7%. It can be concluded that the growth of wage is reasonable.

Figure 4 shows the base run simulation results of the four price indexes. They grow exponentially before 1995, and after that they grow more slowly. All price growth rate reach their peak during the period between 1985 to 1990, then they will decrease gradually in succession. The four average growth rate in simulation period is:

agriculture product > consumption product
>business product > industrial product
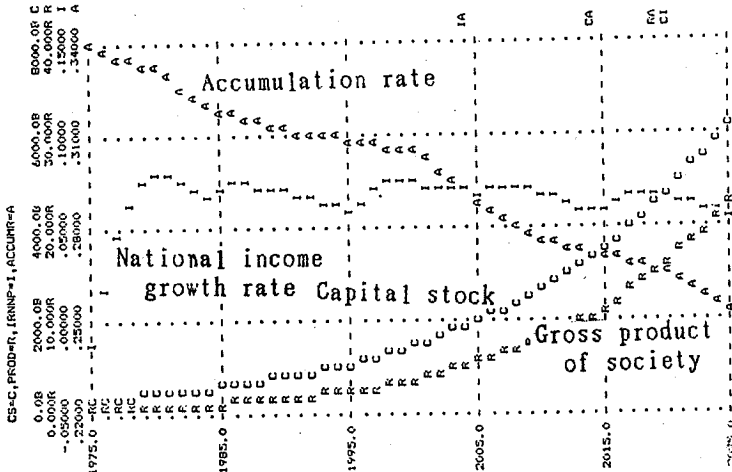
POLICY TEST

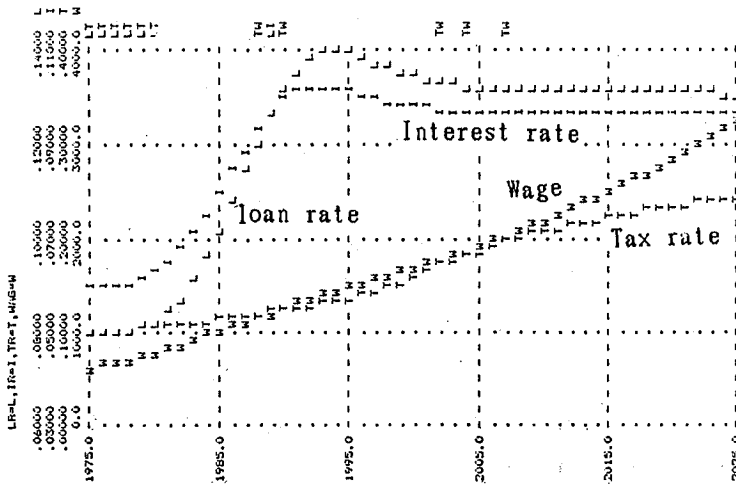Figure 2. The base run results

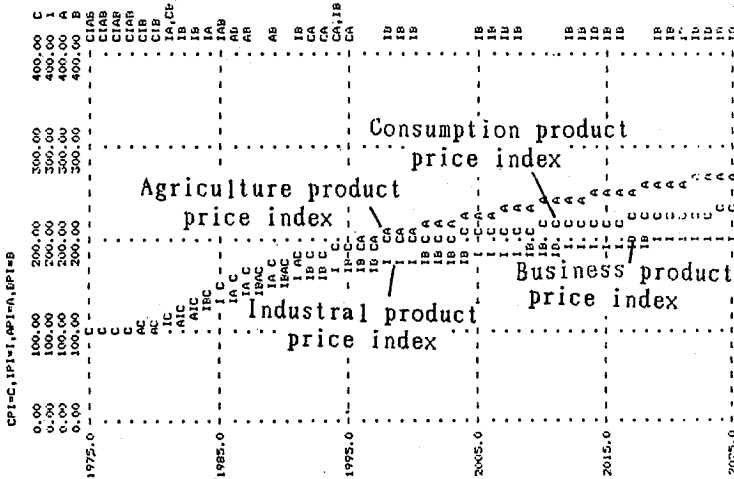Figure 3. The base run result of interest rate, loan rate, wage and tax rate

Figure 4. The base run result of price

The purpose of studying the cooperating and coordinating functions of the economic leverages is to efficiently control national economy. Groups of policy tests are then designed. It includes: the adjustment and control functions of wage, interest rate(loan rate), tax rate and price. The reasonable range of adjustment of economic leverages are studied in these policy tests. Based on above results, several groups of synthetic policy tests are designed to analyze the cooperating functions of some economic leverages.

The following are examples provided to illustrate the policy of increasing tax rate and interest rate if price rises too fast. This policy includes adding 2% or 3% to the tax rate and interest rate from 1990, and from 1990 to 2005.

Table 1. is the results of adding 2% to the tax rate and interest rate from 1990 to 2005.

Table 1. From 1990 to 2005, the results of both tax rate and interest rate being increased 2%.

Time	1992	1994	1996	1998	2000	2025
Interest Rate	9.86% → 25.2%	11.28% → 40.6%	11.80% → 55.6%	11.89% → 69.3%	11.73% → 81.4%	9.64% → 36.4%
Loan Rate	12.36% → 23.3%	14.40% → 38.6%	15.87% → 54.5%	16.30% → 69.9%	16.21% → 84.2%	12.88% → 36.9%
Wage (R.M.B)	1265 → 1249	1373 → 1284	1485 → 1357	1597 → 1449	1721 → 1550	3290 → 2334
Tax Rate	12.4% → 28.8%	12.9% → 44.8%	13.4% → 60.8%	14.1% → 76.8%	14.8% → 92.8%	24.1% → 1.32%
Price Index (e.g. Industrial Product)	174 → 158	198 → 170	220 → 182	241 → 191	259 → 199	321 → 212
Price Index Growth Rate	6.93% → 3.6%	6.36% → 3.8%	5.25% → 3.2%	4.36% → 2.5%	3.64% → 2.6%	2.61% → ‾6.3%

It is found out from this test that increasing the tax rate and interest rate could ease high inflation. The upper limits of the tax rate is 25%, of the interest rate is 14% and loan rate is 18%. Otherwise, the too fast rising tendency of price rising is controlled, but it's difficult to develop production and increase wage.

CONCLUSION

This paper has made systematic, dynamic and quantitative study in adjustment and control functions of coordinately apply the economic leverages. It clearly and wholly shows the mechanism of normally developing national economy.

By analyzing the simulation results of base run between 1975 to 2005 and policy tests, we can obtain the following conclusions:

1. There are numerous factors relating to the financial and monetary system. Any policy making should be based on over-all and long-term

optimal development of economy. Economic leverages should be
coordinately applied to lead China's economy a constant development.

2. The up limits of adjusting prices are about 6% growth rate in the
period of economic reform(1975-2005). After 2005, the prices grow at
the growth rate less than 1%. It is better that the wage growth rate
is between 2% to 4%. In the first period of wage reform(1975--2005),
it get to 6% because of the smaller initial wage. The tax rate
increase from 10% to 25% gradually. The adjustment range of the
interest rate is 8% to 10%. The increase rate of the amount of money
supply should be controlled strictly.

The model is set to supply a laboratory to study and analyze the
economic system. By simulating the problems emerging from China's
economy, we can find out the way to improve the behaviors of system.
It is useful for making economic policies more scientifically.

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