

The Exploration of China SD Macro-economy Model and Economic Cycle

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ABSTRACT A simplified macro-economy model of China is presented. Like the System Dynamics National Model of the US, the major theory and methodology we based on to create the model are system dynamics (SD) and economic theory. Another important basis of modeling is the national statistical almanacs of China. The functions of the model and its value are explained.

Keywords: System Dynamics; Macro-economy; Dynamic Model.

0. Introduction

Of all the fluctuations resulting from economic activities, economic long wave is the most confusing and intricate, especially as far as China economy is concerned. With the trend of global economy, China economy is joining in the world economy more and more. Therefore, it become an urgent issue to study the theory of economic long wave. To reach that goal, we start from the most fundamental point, that is to say, build up a simplified SD national macro-economy model.

1.Theory and task to build up SD model

By reference to the SD National Model of the US, our simplified SD macro-economy model is based on the theories and methodologies of system dynamics and macro-economics, with National Statistical Almanac and National Labor Statistical Almanac as its data basis. The main task of the model involves two aspects: one is to find out the relations between each economy sector, so that we can analyze the dynamic course and relations between these sectors quantitatively by dynamic simulating; the other is to make the model real and valid, that is to say, to keep the main macro-economy variables consistent with the historical data (data in the national statistical almanac), at least in the trend to change.

The theory and methodology to create SD model are embodied by the following 3 points:

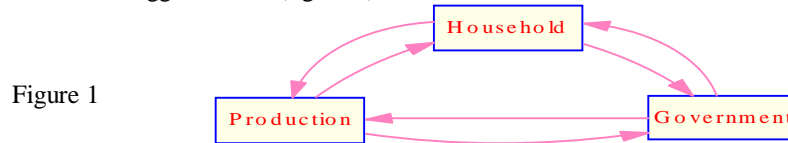
First, by studying the method to build up SD National Model of the US, we create the main feedback structure in some sub-sectors. However, the SD National Model of the US is such a large model, and the model we are going to build is such a simplified one that they have much difference in details. Here we start from systems theory to build up a model that accords with scientific logic system, depending mainly on the theories and methodologies of SD and macroeconomics. Apparently, we have very large difference in country situations with the US, especially in economic mechanism. New China copied the planned economy system of ex-USSR in the first 30 years, which will certainly affect the mode of information feedback of the whole system and the method used to adjust the system. Take the price as the most obvious example, in New China the price of workforce and many other commodities is controlled by the government,

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not the market. Therefore some exogenous variables are introduced to show this trait, such as the price of workforce---wage which is estimated according to the data on National Statistic Almanac. And other parameters are determined by stimulating. Obviously, concerning some details, we can't copy the American Model, but should adjust it by computer simulation.

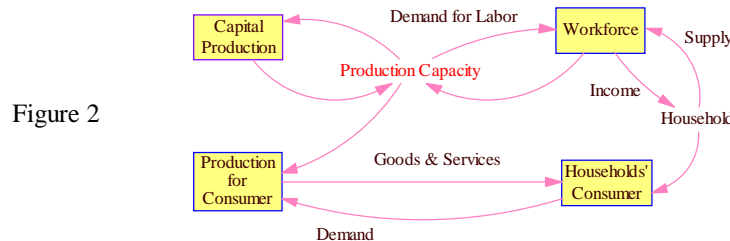
2.The whole structure of the model

There are six main sub sectors in SD National Model of the US. To simplify the model, they can be combined to three bigger sectors (figure 1).



There is complicated exchange of information and materials between the 3 sectors. However, to make the beginning easy, we put focus on production and make light of the effect of government temporarily. The effect of government can be replaced by some exogenous variables temporarily, so that we merely need to analyze the relations between the two sectors.

From figure 2 we can find out that the core of the model lies in production sector. In order to reduce the complexity of the model, we think much of the society production sector. So some simplification is made to the family sector. First, resuming that the supply of the workforce is sufficient, we discuss the demand of the workforce that is mainly determined by production capacity. Second, family income is the primary element that affects consumption. And the price of workforce providing by family is exogenous, not determined by workforce market. Third, production capacity is determined by production function



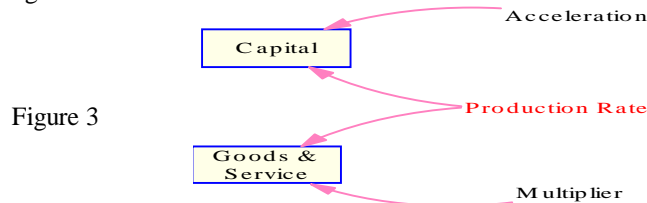
The effect of the government involves two aspects----government and finance, which are substituted by 3 exogenous variables to simplify the model. They are investment of permanent assets from statistical almanac, government consumption and interest rate of resident savings. Of course, price index is also regarded as exogenous variable and only work in the field of consumption.

There are 11 levels in the model totally. Four of them are SMOOTHes, and others are capital level in the production of capital goods, consumable stock in the production of consumables, workforce at work from families and family saving, etc. In addition, there are 11 rate variables in the model, in which increase of capital goods per year, depreciation of capital goods per year, increase of consumables per year, production rate, hire rate, family income and family consumption per year are the most important. Other rate variables are mostly order rates. Furthermore, in the model there are more than 100 equations, which involve some parameters and table functions as constants. They'll be discussed specially in the following part. To sum up, the model is a small one and easy to adjust and run.

3. Sub-sectors of the model

There're mainly 3 sub sectors in the model---production sub-sector, workforce sub-sector and family sub-sector.

As you see in figure 3, production sub-sector is made up of 3 parts---production of consumables, production of capital goods and production capacity. The influence on the production of capital goods comes from two pieces of important feedback information. One is the information about investment of permanent assets, which is a very important feedback information source that constitutes the increase of capital goods. Perhaps because planned economy was implemented for a long time, especially when it comes to the construction of some large infrastructures. Even now we still continue to use the mechanism of planned economy to plan and build them. Therefore accelerating theory can properly describe the internal relation that make economy go up. The other feedback information comes from total production capacity of the society, which is a kind of objective restriction. In fact the total production capacity can be viewed as the society latent production capacity. This information feedback is an important element that constitutes the demand of capital goods too.



Similarly, two factors affect the production of consumables. One comes from the saving in family sector, from which we can get net investment, something just like investment of permanent assets. From all these information together, by principle of multiplier we can get the desired increase of consumable production, then get the feedback information to consumable production. The other factor is the restriction of social latent production capacity, just like the production of permanent assets. Here, principle of multiplier doesn't determine the increase rate of consumable production completely, but is only a kind of desired output. When it work in the production, it will affected by other factors, such as efficiency and objective production capacity, etc.

In production sector, we use the production function in classical model. Here it certainly means the relation between total production capacity of the society and capital, workforce. If the total production capacity is labeled by Y, then $Y = A \cdot K^\alpha \cdot N^\beta$

When $\alpha + \beta = 1$, we call it scale return is constant. And in this condition we can define Y/N as output rate of workforce, Y/K as output rate of capital, which we can get inside the model.

In the workforce sector the demand to workforce is mainly considered, and is calculated from the view of production. Here, wage of the workforce is an exogenous variable which is determined by the actual wage in China National Statistical Almanac (that is income divided by amount of workforce). Moreover, the model about unemployment rate is ignored temporarily.

In the family sector we put focus on income and consumption that consists of commodities and service. And the supply of workforce from family is sufficient.

4. Result of simulation

To build up the model, we use the latest SD software---Vensim. The length of the simulation is 45 years, from 1952 to 1996. Once fixing the initial values and inputting the exogenous variables, we

can operate the model after some slight adjusting. The initial value of the workforce is 207290 thousand persons. The initial value of the productivity is 55000 million RMB (according to the price of that year). The initial order of the consumables is 37500 million RMB. The following is the result:

1. In figure 4 you can see 2 curves about GDP. Curve1 (TGDP) stands for the GDP from statistical almanac; curve2 (GDP) is the result of simulation. The unit is RMB/year. Obviously, the difference between them is very small relatively, and they are consistent in the developing trend, which is just we expected.
2. In figure 5 you can see 2 curves about workforce. Curve1 (Tworkforce) stands for the workforce from statistical almanac; curve2 (Workforce) is the result of simulation. The unit is person. As you can see from the figure, the two curves have difference in some periods, but they are uniform in developing trend, which can meet the requirement already.

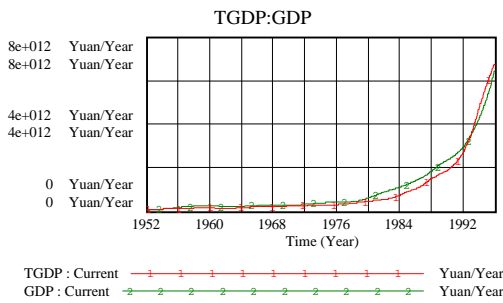


Figure 4

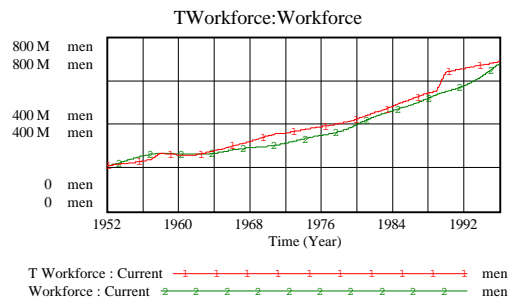


Figure 5

3. In figure 6 you can see 2 curves about the output per capita. Curve1 (TWOR) stands for the data from statistical almanac; curve2 (WOR) is the result of simulation. The unit is RMB/person·year. From the figure we can see the two curves have certain difference in two phases. From 1955 to 1993 the result of simulation is higher than actual data, which is caused by recessive unemployment (that is to say, actual workforce is lower than the data from statistical almanac), because the simulation result of GDP is higher than the data from almanac that phase. The other phase is from 1993 to 1996, when simulation result is lower than statistical data. The reason can be found from the difference of workforce. Nevertheless, the simulation result is still reliable. At least, their trends of development are consistent in the past 45 years.

Of course, we can offer curves about more variables, such as family saving.

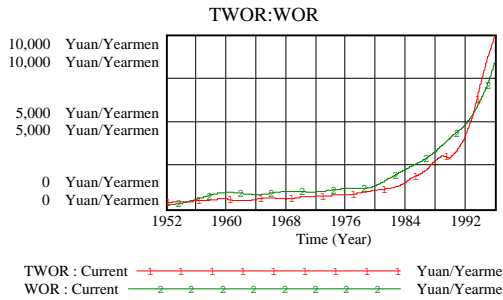


Figure 6

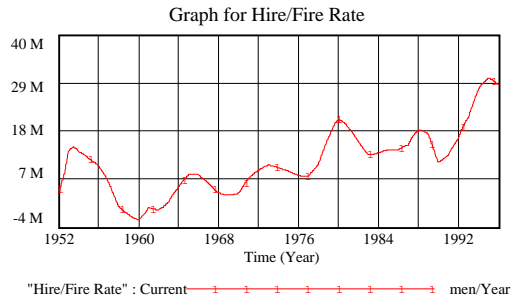


Figure 7

5. Analysis with instances and an interesting conclusion

In the foregoing part, the result of simulation has been described. In fact, by using the result we can make some discussion on the situations of our economy in the past 50 years. Take Hire/Fire

Rate for example (figure 7).

The equations related to H/F Rate are as following:

$$\text{Hire/Fire Rate} = (\text{desired workforce} - \text{workforce level}) / \text{Adjustment Time of workforce}$$

$$\text{Desired workforce} = \text{desired production capacity} / \text{average productivity}$$

Therein, desired production capacity is determined by output per year and a correlative fraction (IPD Fraction).

$$\text{IPD Fraction} = (\text{consumption per year} + \text{capital depreciation per year} + \text{change of consumable stock}) / \text{output rate per year}$$

From the foregoing analysis it can be speculated that there may be a short cycle of 7-8 years in the base run of our economy. Furthermore, from the viewpoint of history, we can find some special factors that influenced the development of economy in 1961, 1968-1970, 1976-1977, 1983, 1990, such as “3-year Natural Disaster” and “Culture Revolution”, the economy has been at the edge of collapse*, etc. And you can also notice the points with distinct characteristic in the figure corresponding to these years. The historical data and the result of simulation are so similar that we have enough reason to believe in the existence of economic cycle and the validity of the model.

6. Summary

According to the result of simulation, we have reached the goal to create the model. Then, what other functions does the model have? It has 3 kinds of function at least.

First, as we have discussed, it can be used to study the economy cycle and its cause of formation.

Second, it can be used to study economy long wave, for example, whether there is a long wave in our economy, and whether it will affect our economy. More discussion about the issue will be presented after further study.

Third, after the model is improved, that is to say, all the exogenous variables become endogenous, we can make some policy analysis and forecast about development trend. Certainly what is the most important is to study the long-term development and the effect of long wave to other economy factors, which is our ultimate goal to create the model, and our goal to strive as well.

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* It's the most popular saying from the end of 1976 to 1977.