

## Medical Health Resources Allocation in Liaoning Province Based on System Dynamics

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### Abstract

On the perspective of social security and the complex system theory, we discuss the choice of the path to the sustainable development of medical health resources in Liaoning province, and then provide theory support for perfecting medical and health resources in Liaoning province by building a system dynamics model on simulation software AnyLogic6.4.1 platform.

**Key words:** System dynamics; Medical health resources; Liaoning

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### INTRODUCTION

Achieving health equity plays an important role in constructing and achieving a civilized, prosperous and happy Liaoning. It is necessary for the improvement of people's health and well-being and meeting the growing demand for health services, to solve the rational allocation of healthy resources, and do utmost to make medical health resources utilization in a efficiency and fairness way. Developed countries' successful story about the allocation of medical health resources is worthy of our

learning. But in view of different countries, different regions, doctrinairism, applying mechanically developed countries' success to ourselves, will not work. As a major economic province, an opening window to the world in Bohai Sea, especially being as an important coastal economic belt in national strategy by the State Council, Liaoning's economy is developing rapidly in the fast lane. So firstly to seize this historic and favorable opportunity to plan initiatives to protect and improve people's livelihood referencing to Liaoning's actual situation on the "new round of" national medical reformation and the "Twelfth Five-Year Plan" is important. And then to enhance and improve the health services accessibility to Liaoning residents through correctly classifying the region by representative scientific feature, and allocating health resources according to different types also has an important practical significance on achieving Liaoning province's innovative, scientific, harmonious and leapfrog development.

### 1. SOURCES OF INFORMATION

The study is on the basis of data Liaoning Health Statistics Yearbook, and Liaoning Statistics Yearbook of and China Health Statistics Yearbook from 2003 to 2010.

### 2. DESIGN OF STUDY

#### 2.1 Underlying Assumption

A model is an abstraction of a real system. So it is essential to make reasonable assumptions to analyze and describes the actual system and try to simplify the overly complex details of the system at the same time. This model is primarily based on the following underlying assumptions:

a. There is no consideration about the time value of money. Money has time value. Also, there is a close

relation between the time value of money and inflation rate. Without prejudice to the premise of the model accuracy, this study looks the inflation rate as exogenous variables, so, medical institutions' income will not consider time value of money.

b. Government investment in the health system will be materialized for a variety of medical health resources. The model assumes that the increment of health resources and the government's input is fully positively correlative.

## 2.2 Study Variables

The simulation study was based on the current level of medical health resources. It observes the changes of fixed assets, doctors and nurses 'number by selecting medical institutions of the city (city hospital, community health institutions) and rural medical institutions (county hospital and township) as study object, by making public finance grant, the higher authority grant, medical income, drug income, other income, the average worker operations and health care income as underlying variables, and by regarding financial investment ratio, the proportion of investment ratio in fixed assets, medical technician input ratio, and teleconsultation as adjustment of parameters.

## 2.3 System Dynamics Model and Main Equation

Fixed assets of hospital = total investment of fixed assets – accumulated depreciation of fixed assets.

Number of hospital doctors = medical health technical personnel\*health care.

Hospital incremental income of fixed assets = hospital income \*the rate of fixed assets investment.

The depreciation of fixed assets = hospital fixed assets\* depreciation rates of fixed asset.

Hospital income= financial grant of hospital + financial grant of higher authority of hospital+ medical income of hospital+ drug income of hospital+ other income of hospital.

## 3. RESULTS OF STUDY

### 3.1 Testing of Initial Model

We firstly build the system of dynamics model according to the allocation of medical and health's relationship, next, defined variables and their relationships, then input the original data into AnyLogic6.4.1 software, and finally have a simulation on health resources system of Liaoning province. In order to guarantee the effectiveness of simulation data, it firstly needs to test the simulation model. In general this test calculates the two indicators, relative error percentage and mean square errors by comparing simulated and real data.

**Table1**  
**Observation Index Inspection**

| Year | Observation index                     | Real data   | Simulation data | Relative error | RMS   |
|------|---------------------------------------|-------------|-----------------|----------------|-------|
| 2009 | City hospital fixed assets            | 17126806921 | 18590001417     | 0.085          | 0.118 |
|      | City hospital doctors                 | 51288       | 47492.50449     | -0.074         |       |
|      | City hospital nurses                  | 49277       | 53415.74277     | 0.084          |       |
|      | County hospital fixed assets          | 2842468004  | 3089762720      | 0.087          | 0.121 |
|      | County hospital doctors               | 25774       | 27346.40223     | 0.061          |       |
|      | County hospital nurses                | 15137       | 14486.31505     | -0.043         |       |
|      | Community healthy agency fixed assets | 349702140   | 381874736.9     | 0.092          | 0.131 |
|      | Community healthy agency doctors      | 3322        | 3584.492813     | 0.079          |       |
|      | Community healthy agency nurses       | 3192        | 3364.13011      | 0.054          |       |
|      | Township hospital fixed assets        | 1112925771  | 1189717649      | 0.069          | 0.104 |
|      | Township hospital doctors             | 17495       | 19209.24964     | 0.098          |       |
|      | Township hospital nurses              | 10275       | 11168.60108     | 0.087          |       |

Sources of information: Liaoning Provincial Health Statistics Yearbook.

As we can see from the table, the relative errors between simulation and real data are less than 10%. Despite the RMS data is not ideal because of the difficulties in obtaining the model part of the actual data, it still belong to the acceptable range. The author assumes the formation of the simulation data according to the macroeconomic statistics and theoretical distribution method. So, there must be some inevitable errors with the actual situation

### 3.2 Results of the Simulation Experiment

Urban and rural medical health resources still have a huge gap under the current policy, seeing from the results of simulation experiments.

And, by 2020, this gap has no tendency to be small. Fixed assets gap will become greater and be large. The gap between doctors' and nurses' numbers have slight tendency to increase. From the perspective of experimental results, growth of fixed assets significantly is apparently faster than the growth of health human resources over in the next 8 years.

The growth rate of fixed assets is individually 179% in city hospital, 124% in county hospital, 274% in community health agency, and 406% in Township hospital. Its growth is evident. The slowest growth of county hospital is also over doubled. The growth of community hospital and township hospital are more than twice. However,

human resources for health care is individually 52% in city hospital, about 57% in county hospital, 74% in community health agency, and only 2.8% in the slowest township health hospital. It is obvious lower than the growth in fixed assets.

The data is shown in Table 2.

**Table 2**  
**Data Predictability of Medical Resources in Liaoning**

| Year | City hospital                                |                    |                   | County hospital                              |                    |                   | Community health agency                      |                    |                   | Township hospital                            |                    |                   |
|------|----------------------------------------------|--------------------|-------------------|----------------------------------------------|--------------------|-------------------|----------------------------------------------|--------------------|-------------------|----------------------------------------------|--------------------|-------------------|
|      | Predictability of fixed assets (ten million) | Numbers of doctors | Numbers of nurses | Predictability of fixed assets (ten million) | Numbers of doctors | Numbers of nurses | Predictability of fixed assets (ten million) | Numbers of doctors | Numbers of nurses | Predictability of fixed assets (ten million) | Numbers of doctors | Numbers of nurses |
| 2013 | 5105.319                                     | 50216              | 48247             | 473.936                                      | 20729              | 13819             | 71.064                                       | 4131               | 3664              | 270.763                                      | 27946              | 16413             |
| 2014 | 5951.851                                     | 53710              | 51604             | 523.835                                      | 21515              | 14343             | 85.374                                       | 4391               | 3894              | 342.893                                      | 27924              | 16400             |
| 2015 | 6915.928                                     | 55716              | 53531             | 582.253                                      | 22333              | 14889             | 102.727                                      | 4672               | 4143              | 433.002                                      | 27934              | 16406             |
| 2016 | 8015.45                                      | 58363              | 56075             | 650.549                                      | 23867              | 15911             | 123.805                                      | 4982               | 4418              | 545.748                                      | 27984              | 16435             |
| 2017 | 9272.152                                     | 61689              | 59270             | 730.38                                       | 25488              | 16992             | 149.45                                       | 5320               | 4718              | 687.079                                      | 28078              | 16490             |
| 2018 | 10712.729                                    | 65755              | 63176             | 823.777                                      | 27447              | 18298             | 180.716                                      | 5692               | 5048              | 864.72                                       | 28230              | 16580             |
| 2019 | 12368.546                                    | 70648              | 67878             | 933.147                                      | 29787              | 19858             | 218.872                                      | 6103               | 5412              | 1088.236                                     | 28447              | 16707             |
| 2020 | 14281.568                                    | 76479              | 73480             | 1061.631                                     | 32538              | 21692             | 265.658                                      | 7174               | 6362              | 1371.284                                     | 28734              | 16876             |

#### 4. THINKING AND POLICY RECOMMENDATIONS

Health resources allocation has always been the core of the medical security system. If we want to change the unfair and unreasonable health resources allocation situation and development tendency in Liaoning, the government must establish a compliance configuration framework to Liaoning's economic development, admit the medical health resources gap between urban and rural, increase government spending, change the allocation structure of primary care health human resource, and then meet urban and rural residents' needs of the medical health resources.

a. The urban and rural gap is not only in terms of medical and health resources allocation, but also in the level of economic development, residents' consumption and the education. The medical health institutions of the city can have a lot of high quality resources because of historical reasons. Even now, we put all the money in the medical health institutions of rural areas, it is still impossible to reach the total level of urban medical health resources in a short time. Moreover, there is no necessary link between the investment in medical health resources and fairness' improvement. Medical health resources allocation between urban and rural does not necessarily mean fair, because absolute fairness is not fair. The result, allocating health resources configuration under the ignorance of urban and rural residents' differences in health services' demand, consumption level, health

consciousness, is not fair. But the acknowledgement of urban-rural gap does not mean making the gap large. Instead, we should allocate health care resources under the principle of narrowing the gap.

b. The Government should continually increase the investment in health care. The economy in Liaoning has been achieving a leapfrog development since the "Eleventh Five-Year". Total economy in Liaoning has become seventh in the country's total economy. GRDP has achieved an annual growth, 14%. The disposable income of per urban resident and the net income of per rural resident have respectively grown 11.4 % and 9.3%. All the data shows that Liaoning's overall economic strength has become the fastest in all the provinces. The rapid development of the economy dwarf the government's investment in the protection of people's health care. The total amount of government's investment in health care has increased significantly since "Eleventh Five-Year". But the ratio of investment is slightly lower than economic growth of the same period and the national average. If the medicare related to people's livelihood and well-being and high growth in economy could not be improved and enhanced at the same time and people do not see or obtain the welfare benefits in their expectation from the economic growth, that will lead to the conflicts of interest and the intensification of social contradictions and be a potential threat on sustainable economic development and social harmony. So, the government should change the existing model and proportion of the investment of medical health, continually increase the investment with

the growth of GDP, and take the investment of social security as the core indicators to measure public nature of government finance.

c. We should make the improvement of primary health care as a strategy of prior development. Medical health human resources are the focus of medical health resources allocation and the critical resources related to the development. The quality of primary human health care resources not only directly influences the growing numbers of advanced medical equipment's functional role, but also have a more direct impact on the quality of health service and capacity of sustainable development. Therefore, the allocation of human health resources the determines the success or failure of the overall allocation. Attention on the particularity of human health care resources, strengthen on the building of health personnel, and improvement on the quality and quantity of human health care resources should be placed in the prior position in development.

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