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# Economic development and social governance efficiency evaluation research based on SBM model

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**ABSTRACT**

*This paper presents a SBM model with variable of negative output, based on slack variable, then we divide the whole society into economic development system and social governance system, evaluate economic development and social governance efficiency of 31 provinces of China during 2010-2012 with negative output SBM model, SBM network model and dynamic network SBM model. The results showed that the Midwest provinces kept good economic efficiency these years, while the eastern provinces continuously decreased; the Midwest provinces also kept good social governance efficiency, which derives from better natural environment and less population, Beijing, Tianjin, Shanghai and Zhejiang both kept social governance efficiency, which derives from perfect economy transition and social security system. As for network effect, most provinces network efficiency are lower than single efficiency except Xizang. As for dynamic effect, Fujian and Guizhou is not positive of single efficiency but positive on dynamic efficiency, which shows the two provinces have good recycling of resources.*

**Key words:** Energy; Energy structure; Markov Chain; Energy prediction; Energy policy

## INTRODUCTION

Over the past 30 years, China's extensive development model has caused a lot of social problems in addition to the economic growth. These problems are embodied in environmental pollution and social stability. Under the conditions of limited resources, how to balance the economic development and the social governance, reduce the environmental pollution, reasonably distribute the social wealth and maximize the efficiency of resource use has become the main problems faced by China's economic and social transformation. In this paper, the whole society has been divided into the economic development system and the social governance system. Based on slack variable, SBM model with negative output has been proposed so as to evaluate the efficiency of economic development system and social governance system; the three industrial wastes and the financial revenue generated by economic development system act on the social governance system and the network effects between subsystems are presented. Therefore, it is required to introduce the network SBM model. At the same time, the production at the current stage will be applied to all stages in future, so the dynamic effects have been considered in this paper so as to analyze the comprehensive efficiency of more systems.

## EFFICIENCY EVALUATION METHOD BASED ON SBM MODEL

### 1. SBM model

SBM model is firstly proposed by Tone (2001) which includes three variable models: input model, output model and undirected model. The undirected model is the integration of input model and output model. It has been widely applied. Therefore, the undirected model is employed in this paper. Assuming that there are *n* decision-making units and each decision-making unit $DMU_j(j=1,2,\ldots,n)$ has *m* kinds of inputs and *s* kinds of outputs. The input vector and the output vector of decision-making $DMU_j$ can be represented as $(x_{1j}, x_{2j}, \ldots, x_{mj})^T$ and

$(y_{1j}, y_{2j}, \ldots, y_{sj})^T$ . Then, the input-output matrix composed by all decision-making units can be defined as follows:

$$X = (x_1, x_2, \ldots, x_n) \text{ and } Y = (y_1, y_2, \ldots, y_n)$$

Production possibility set can be represented as:

$$P = \left\{ (x_0, y_0) \middle| x_0 \geq \sum_{j=1}^{n} \lambda_j x_j, 0 \leq y_0 \leq \sum_{j=1}^{n} \lambda_j y_j, y_j \geq 0 \right\}$$

Through introducing the slack variables, the inequality constraints can be transformed into the equality constraints:

$$x_0 = \sum_{j=1}^{n} \lambda_j x_j + s_0^- \quad y_0 = \sum_{j=1}^{n} \lambda_j y_j - s_0^+ \quad s_0^- \geq 0, s_0^+ \geq 0$$

Thus, the undirected SBM model established by Tone can be represented as:

$$\theta^* = \min \left[ \left( 1 - \frac{1}{m} \sum_{i=1}^{m} \frac{s_{i0}^-}{x_{i0}} \right) \Big/ \left( 1 + \frac{1}{s} \sum_{r=1}^{s} \frac{s_{r0}^+}{y_{r0}} \right) \right] \quad (1)$$

S.t.:

$$x_0 = \sum_{j=1}^{n} \lambda_j x_j + s_{i0}^- \quad y_0 = \sum_{j=1}^{n} \lambda_j y_j - s_{r0}^+ \quad s_{i0}^- \geq 0, s_{r0}^+ \geq 0, \lambda \geq 0$$

When $\theta^* = 1$, $s_0^- = 0, s_r^+ = 0$ .All input and output slack volumes are zero, then the decision-making unit is the effective SBM. The above undirected SBM model is a nonlinear programming, which can be transformed into the linear programming by charnes-cooper (1962). The transformation results are as follows:

$$\tau^* = \min \left( t - \frac{1}{m} \sum_{i=1}^{m} \frac{s_{io}^{-\bullet}}{x_{io}} \right)$$

S.t.:

$$1 = t + \frac{1}{s} \sum_{r=1}^{s} \frac{s_{ro}^{+\bullet}}{y_{ro}}$$

$$tx_{io} = \sum_{j=1}^{n} \lambda_j^{\bullet} x_{ij} + s_{io}^{-\bullet} \quad (i = 1, \ldots, m)$$

$$ty_{io} = \sum_{j=1}^{n} \lambda_j^{\bullet} y_{rj} - s_{ro}^{+\bullet} \quad (r = 1, \ldots, s)$$

$$\lambda_j^{\bullet} \geq 0, s_{io}^{-\bullet} \geq 0, s_{ro}^{+\bullet} \geq 0, t > 0$$

Among them, $t = 1 \Big/ \left( 1 + \frac{1}{s} \sum_{r=1}^{s} \frac{s_r^+}{y_{ro}} \right)$, $\lambda_j^{\bullet} = t\lambda_j, s_{io}^{-\bullet} = ts_{io}, s_{ro}^{-\bullet} = ts_{ro}$

**2. Properties of negative output and negative input as well as the treatment methods**

In the economic system, some products can be output through entering certain input. Some products are demanded by us, such as profits and GDP, etc. And there are also some non-desired outputs, for example, the three industrial wastes are harmful to the environment and the production efficiency of decision-making unit can be reduced. This kind of output is called the negative output. The one that is contrast to the negative output is the negative input. It is usually hoped that more outputs can be obtained with fewer inputs. However, for the negative input, it is hoped that the negative inputs of enterprises should be more, for example, the enterprises should take the social responsibility

in the production process of products.

Currently, the treatment of negative input has not been systematically outlined and the model researches on negative input are rarely involved. According to the relevant characteristics of negative input, several treatment methods are proposed: (1) it is required to give the negative weights to negative input. The negative input is stilled treated as an input. All inputs should be conducted the weighted summation and the weight of negative input is negative. (2) it is necessary to respectively calculate the technical efficiency and the social responsibility efficiency. The positive input is mainly used in creating the corporate profits to form the technical efficiency; the negative input is a matter of corporate responsibility to form the social responsibility efficiency. In the specific evaluation, the two efficiencies can be respectively calculated and the total efficiency can be obtained through the weighted summation of two efficiencies. (3) It is demanded to adopt the treatment method that is contrary to the negative output. For example, the distance function method selects the improvement method that can reduce the positive input and increase the negative input; the negative input and the positive input change with the opposite ratio; the negative input is treated as the output, etc.

**3. SBM model with negative output and negative input**

According to the analysis on the characteristics of negative output and negative input, the negative output should become as small as possible and the negative input should become as large as possible, i.e. the negative output has the similar nature of input variables and the negative input has the similar nature of output variables. Therefore, the negative output is considered as the input variable and the negative input is considered as the output variable in this paper. The basic SBM model is expanded so as to obtain the SBM model with negative output and negative input:

$$\theta^* = \min\left[\left(1-\alpha\frac{1}{m}\sum_{i=1}^{m}\frac{s_{i0}^-}{x_{i0}}-\beta\frac{1}{b}\sum_{l=1}^{b}\frac{s_{l0}^-}{u_{l0}}\right)\Big/\left(1+\omega\frac{1}{s}\sum_{r=1}^{s}\frac{s_r^+}{y_{r0}}+\theta\frac{1}{n}\sum_{h=1}^{n}\frac{s_{h0}^+}{z_{h0}}\right)\right]$$

S.t.:

$$x_0=\sum_{j=1}^{n}\lambda_j x_j+s_{i0}^- \quad y_0=\sum_{j=1}^{n}\lambda_j y_j-s_{r0}^+ \quad u_0=\sum_{j=1}^{n}\lambda_j u_j+s_{i0}^- \quad z_0=\sum_{j=1}^{n}\lambda_j z_j-s_{h0}^+$$

$$\sum_{j=1}^{n}\lambda_j=1, s_{i0}^-\geq 0, s_{r0}^+\geq 0, s_{l0}^-\geq 0, s_{h0}^+\geq 0, \lambda_j\geq 0$$

Among them, $s_{i0}^-$, $s_{r0}^+$, $s_{l0}^-$ and $s_{h0}^+$ respectively represent the positive input, the positive output and the slack variable of negative input and negative output. $\lambda_j (j=1,2,\ldots,31)$ represents the weight vector of the provincial decision-making unit. It is required to meet $\alpha+\beta=1$ and $\omega+\theta=1$. $\alpha$ and $\beta$ respectively refer to the weight distribution between positive input and negative output. The policymakers can give the different values in accordance with experience and preference, which can reflect the trade-offs of policymakers between the resource conservation and the reduction of pollution emissions. $\omega$ and $\theta$ respectively represent the weight distribution of positive output and negative input. The policymakers can give the different values, which can reflect the trade-offs of policymakers between the pursuit of maximum business benefits and the social responsibility. Similar to the basic model, the SBM model with negative output and negative input also belongs to the nonlinear model which can be transformed into the linear programming through charnes-cooper.

**EMPIRICAL RESEARCH**

In this paper, the economic development and the social governance are adopted to expect to obtain a more reasonable efficiency evaluation value while assessing the performance of Chinese mainland's 31 provincial administrative regions. And the efficiency improvement directions are also provided.

**1. Description of Chinese economy and social governance system**

In this paper, the provincial decision-making units are divided into the economic development system and the social governance system (Figure 1).The economic development system refers that a certain human and material resources are input to produce the various material goods as well as some unnecessary negative output (such as environmental pollutants). The social governance system is mainly used to solve the social environmental problems and the employment c can be promoted through the social security. At the same time, through the environmental input, the environmental pollution generated by economic development system can be processed and the living environment of

people can be improved. The economic development system and the social governance system are not isolated. The economic revenue of positive output of economic development system can be used in the social security and the environmental input of social governance system. the negative output of economic development system such as the three industrial wastes and the wealth gap can be considered as the input of social governance system. At the same time, the harmonious environment formed by the output of social governance system and the value generated by treatment of three industrial wastes will form a positive effect on the economic development system.

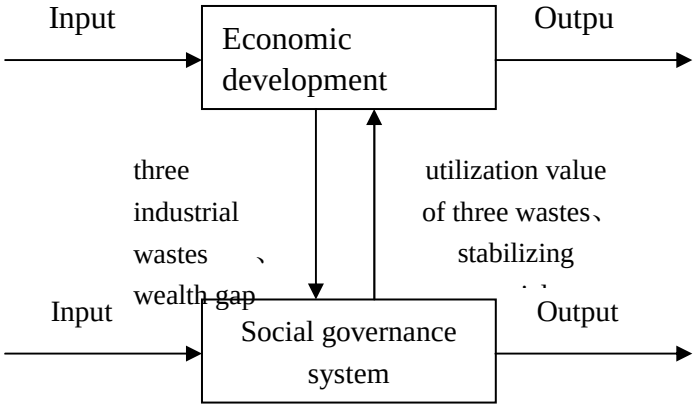


**Fig. 1 Relationship between economic development system and social governance system**

## 2. Evaluation index selection and results analysis

In view of the dynamic and network effects, the negative input indicators are difficult to be quantified. In this paper, the negative output is brought into the model. According to the selected index, the provincial administrative units are considered as the decision-making units and the index data of 31 provincial administrative units in 2010-2012 are collected. The data are from the China Statistical Yearbook, the China Environment Statistical Yearbook and the China Energy Statistical Yearbook.

**Table 1 Economic development efficiency and social governance efficiency of each province in 2010-2012**

| Decision-making unit | Economic development efficiency | | | Social governance efficiency | | |
|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2010 | 2011 | 2012 |
| Beijing | 0.3475 | 0.3456 | 0.3443 | 1 | 0.6151 | 1 |
| Tianjin | 0.4755 | 0.4446 | 0.4346 | 1 | 1 | 1 |
| Hebei | 0.4184 | 0.4865 | 0.3743 | 0.4408 | 0.4293 | 0.4369 |
| Shanxi | 0.4072 | 0.4066 | 0.4091 | 0.4786 | 0.4839 | 0.5093 |
| Inner Mongolia | 0.5244 | 0.4124 | 0.4133 | 0.44 | 0.4408 | 0.4354 |
| Liaoning | 0.3799 | 0.381 | 0.3852 | 0.4267 | 0.4335 | 0.4426 |
| Jilin | 0.4393 | 0.4581 | 0.4725 | 0.4381 | 0.4587 | 0.4574 |
| Heilongjiang | 0.4328 | 0.4306 | 0.4419 | 0.4797 | 0.4742 | 0.4918 |
| Shanghai | 0.3619 | 0.3532 | 0.3562 | 0.4639 | 0.464 | 0.4755 |
| Jiangsu | 0.3495 | 0.3531 | 0.3498 | 0.4135 | 0.4206 | 0.4423 |
| Zhejiang | 0.3535 | 0.3576 | 0.3572 | 0.4718 | 0.4569 | 0.4713 |
| Anhui | 0.3919 | 0.4531 | 0.4591 | 1 | 0.4505 | 0.4908 |
| Fujian | 0.3814 | 0.384 | 0.3891 | 0.4472 | 0.4548 | 0.4585 |
| Jiangxi | 1 | 1 | 0.5885 | 0.4231 | 0.4315 | 0.4408 |
| Shandong | 0.3806 | 0.4545 | 0.3587 | 0.4419 | 0.4415 | 0.4353 |
| Henan | 1 | 1 | 1 | 0.4234 | 0.4309 | 0.4473 |
| Hubei | 0.3797 | 0.3882 | 0.3922 | 0.4704 | 0.4477 | 0.4856 |
| Hunan | 0.3873 | 0.3835 | 0.3883 | 0.4302 | 0.4292 | 0.4274 |
| Guangdong | 0.3435 | 0.3471 | 0.3481 | 0.4034 | 0.4087 | 0.3914 |
| Guangxi | 0.398 | 0.406 | 0.4128 | 0.4351 | 0.4356 | 0.4435 |
| Hainan | 1 | 1 | 1 | 0.5417 | 0.5144 | 0.5329 |
| Chongqing | 0.4142 | 0.4377 | 0.4523 | 0.5165 | 0.4991 | 0.5379 |
| Sichuan | 0.3801 | 0.3975 | 0.388 | 0.4264 | 0.4317 | 0.4508 |
| Guizhou | 0.4489 | 0.4103 | 0.4116 | 0.4639 | 1 | 0.5157 |
| Yunnan | 0.4099 | 0.4149 | 0.4197 | 0.4202 | 0.4229 | 0.4133 |
| Xizang | 1 | 1 | 1 | 1 | 1 | 1 |
| Shanxi | 0.5887 | 0.4207 | 0.4303 | 0.4953 | 0.4687 | 0.5176 |
| Gansu | 0.4752 | 0.4906 | 0.5154 | 1 | 1 | 1 |
| Qinghai | 1 | 1 | 1 | 1 | 1 | 1 |
| Ningxia | 0.7265 | 0.6626 | 0.6248 | 1 | 1 | 1 |
| Xinjiang | 0.5312 | 0.5073 | 1 | 1 | 1 | 0.7766 |

In this paper, the positive input and the negative output are put in the equally important position. Assuming that $\alpha = 1/2$ and $\beta = 1/2$, as the negative input index is not considered, so $\omega = 1$, $\theta = 0$.The collected data are brought in the SBM model with negative output and they are processed by Matlab. The obtained results are as table 1.

Overall, some economically developed provinces such as Beijing, Shanghai, Tianjin and Zhejiang have paid more attention to the social governance when the economy is gradually matured. The governments stress the overall development of economic society; however, some central and western provinces such as Jiangxi, Henan and Hunan are more concerned about the economic growth and the social governance efficiency is relatively low; other few provinces are in the adjustment period and the economic efficiency as well as the social governance efficiency has greater volatility.

**EFFICIENCY EVALUATION METHOD BASED ON DYNAMIC AND NETWORK SBM MODEL**

**1. Network SBM model**

According to the SBM basic model and the empirical researches on economic development system and social governance system, the network SBM model is defined as:

$$\theta_o = \min\left[\sum_{k=1}^{2} w^k \left(1 - \alpha \frac{1}{m^k}\left(\sum_{m=1}^{m^k} \frac{s_{n0}^{k\,-}}{x_{n0}^k}\right) - \beta \frac{1}{b^k}\left(\sum_{l=1}^{b^k} \frac{s_{l0}^{k\,-}}{u_{l0}^k}\right)\right) \Bigg/ \sum_{k=1}^{2} w^k \left(1 + \frac{1}{g^k}\sum_{r=1}^{g^k} \frac{s_{ro}^{k\,+}}{y_{r0}^k}\right)\right] \quad (2)$$

S.t.:

$$\sum_{j=1}^{31} x_{nj}^k \lambda_j^k = x_{no}^k - s_{i0}^{k\,-} \quad \sum_{j=1}^{31} y_{rj}^k \lambda_j^k = y_{ro}^k + s_{ro}^{k\,-} \quad \sum_{j=1}^{31} u_{lj}^k \lambda_j^k = u_{lo}^k - s_{lo}^{k\,-} \quad \sum_{j=1}^{31} \lambda_j^k = 1$$

$$\lambda_j^k \geq 0, s_{n0}^{k\,-} \geq 0, s_{r0}^{k\,-} \geq 0, s_{l0}^{k\,-} \geq 0, j = 1, \ldots, 31; k = 1, 2$$

The definition of each variable is similar to formula (1), $x_{nj}^k$, $y_{rj}^k$ and $u_{lj}^k$ represent the input, the positive output and the negative output of the $j^{th}$ decision-making unit of the $k^{th}$ subsystem. $s_{i0}^{-}$, $s_{r0}^{+}$, $s_{l0}^{-}$ and $s_{h0}^{+}$ respectively represent the slack variables of positive input, positive output, negative output and negative input. $\lambda_j (j = 1, 2, \ldots, 31)$ Represents the weight vector of each provincial decision-making unit. $\alpha$ and $\beta$ represent the weight proportions of positive input and negative output, which should meet $\alpha + \beta = 1$. According to the above index selection, it is found that the economic development system and the social governance system respectively have three positive inputs, three positive outputs and a negative output. Therefore, $m^1$=3; $m^2$=3; $b^1$=1; $b^2$=1; $g^1$=3; $g^2$=3。

As formula (2) is the non-linear programming model, which can be transformed into the linear programming through charnes-cooper. The transformed model is shown as:

$$\theta_o^* = \min\left[Q - \sum_{k=1}^{2} \frac{1}{2}\left(\frac{1}{2}\frac{1}{m^k}\left(\sum_{n=1}^{m_k} \frac{s_{n0}^{\bar{kt}\,-}}{x_{n0}^{kt}}\right) + \frac{1}{2}\frac{1}{b^k}\left(\sum_{l=1}^{b^k} \frac{s_{l0}^{\bar{kt}\,-}}{u_{l0}^{kt}}\right)\right)\right]$$

S.t.:

$$Q + \sum_{k=1}^{2} \frac{1}{2}\left(\frac{1}{g^k}\left(\sum_{r=1}^{g_k} \frac{s_{r0}^{\bar{kt}\,+}}{y_{r0}^{kt}}\right)\right) = 1$$

$$\sum_{j=1}^{31} x_{nj}^{kt} \lambda_j^{\bar{kt}} = Q x_{no}^{kt} - s_{no}^{\bar{kt}\,-}$$

$$\sum_{j=1}^{31} y_{rj}^{kt} \lambda_j^{\bar{kt}} = Q y_{ro}^{kt} + s_{ro}^{\bar{kt}\,+}$$

$$\sum_{j=1}^{31} u_{lj}^{kt} \lambda_j^{\bar{kt}} = Qu_{lo}^{kt} - s_{lo}^{\bar{kt}^-}$$

$$\sum_{j=1}^{31} \lambda_j^{\bar{kt}} = Q$$

$$Q > 0 \ \lambda_j^{\bar{kt}} \geq 0 \ s_{no}^{\bar{kt}^-} \geq 0 \ s_{ro}^{\bar{kt}^+} \geq 0 \ s_{lo}^{\bar{kt}^-} \geq 0$$

Among them,

$$Q = 1 \Big/ \sum_{k=1}^{2} w^k \left[ 1 + \frac{1}{g^k} \left( \sum_{r=1}^{g_k} \frac{s_{r0}^{k^+}}{y_{r0}^k} \right) \right], \lambda_j^{\bar{kt}} = Q\lambda_j^{kt}, s_{no}^{\bar{kt}^-} = Qs_{no}^{kt^-}, s_{ro}^{\bar{kt}^+} = Qs_{no}^{kt^+}, s_{lo}^{\bar{kt}^-} = Qs_{lo}^{kt^-}$$

**2. Dynamic network SBM model**

Based on the existing dynamic DEA researches, the dynamic network DEA model is constructed by Tone (2013) and the dynamic network SBM model with negative output is proposed. The specific model is as follows:

$$\theta_o^* = \min \frac{\sum_{t=1}^{3} w^t \sum_{k=1}^{2} w^k \left[ 1 - \alpha \frac{1}{m^k} \left( \sum_{m=1}^{m^k} \frac{s_{n0}^{kt^-}}{x_{n0}^{kt}} \right) - \beta \frac{1}{b^k} \left( \sum_{l=1}^{b^k} \frac{s_{l0}^{kt^-}}{u_{l0}^{kt}} \right) \right]}{\sum_{t=1}^{3} w^t \sum_{k=1}^{2} w^k \left[ 1 + \frac{1}{g^k} \left( \sum_{r=1}^{g^k} \frac{s_{r0}^{kt^+}}{x_{r0}^{kt}} \right) \right]} \tag{3}$$

S.t.:

$$\sum_{j=1}^{31} x_{nj}^{kt} \lambda_j^{kt} = x_{no}^{kt} - s_{no}^{kt^-}$$

$$\sum_{j=1}^{31} y_{rj}^{kt} \lambda_j^{kt} = y_{ro}^{kt} + s_{ro}^{kt^+}$$

$$\sum_{j=1}^{31} u_{lj}^{kt} \lambda_j^{kt} = u_{lo}^{kt} - s_{lo}^{kt^-}$$

$$\sum_{j=1}^{31} \lambda_j^{kt} = 1$$

$$\lambda_j^{\bar{kt}} \geq 0, \ s_{no}^{\bar{kt}^-} \geq 0, \ s_{ro}^{\bar{kt}^+} \geq 0, \ s_{lo}^{\bar{kt}^-} \geq 0$$

Among them,

$$j = 1, \ldots, 31; k = 1, 2; t = 2010, 2011, 2012$$

The definitions of each variable in model (3) are similar to the ones in model (1) and model (2). The weights vectors of positive input and negative output are $\alpha$ and $\beta$. $\alpha + \beta = 1$ should be satisfied. In this paper, the positive input and the negative output are put into the equally important position, namely $\alpha = \beta = 1/2$. For the weight $w^k$ between the economic development system and the social governance system, the economic development and the social governance are equally important. The economic development is the basis to construct the healthy society and the safe and stable social environmental is the internal driving force of economic development, so $w^1 = w^2 = 1/2$. For the time weight $w^t$, the economic development and social governance data in 2010-2012 have been selected and it is thought that each year should have the equal weight, so $w^{2010} = w^{2011} = w^{2012} = 1/3$. Of course, the decision-makers can change the weights in time dimension according to their own preferences, such as the increase of the weights of the nearest year and the reduction of the weights of the farthest year.

## 3. Empirical analysis

### 3.1 Comparative analysis of the empirical results under network effects

The data collected from the China Statistical Yearbook, the China Environment Statistical Yearbook and the China Energy Statistical Yearbook are brought into the network SBM model and the results are shown as follows:

**Table.2 Network system efficiency of each province in 2010-2012**

| Decision-making units | 2010 | 2011 | 2012 |
|---|---|---|---|
| Beijing | 0.3213 | 0.3456 | 0.3433 |
| Tianjin | 0.4251 | 0.4789 | 0.4346 |
| Hebei | 0.2439 | 0.2548 | 0.1545 |
| Shanxi | 0.1847 | 0.171 | 0.2066 |
| Inner Mongolia | 0.248 | 0.1462 | 0.1711 |
| Liaoning | 0.1156 | 0.1339 | 0.1479 |
| Jilin | 0.2044 | 0.2259 | 0.3001 |
| Heilongjiang | 0.2198 | 0.172 | 0.2109 |
| Shanghai | 0.3543 | 0.3724 | 0.3562 |
| Jiangsu | 0.3495 | 0.3531 | 0.1947 |
| Zhejiang | 0.3535 | 0.3576 | 0.3572 |
| Anhui | 0.1684 | 0.2195 | 0.2086 |
| Fujian | 0.2015 | 0.2427 | 0.1827 |
| Jiangxi | 0.2988 | 1 | 0.3362 |
| Shandong | 0.2265 | 0.3082 | 0.1782 |
| Henan | 0.5923 | 0.5516 | 0.5392 |
| Hubei | 0.1497 | 0.1567 | 0.1531 |
| Hunan | 0.1548 | 0.1541 | 0.1707 |
| Guangdong | 0.1203 | 0.1954 | 0.1186 |
| Guangxi | 0.1936 | 0.2662 | 0.1724 |
| Hainan | 1 | 1 | 1 |
| Chongqing | 0.1843 | 0.2262 | 0.2157 |
| Sichuan | 0.1234 | 0.1456 | 0.1187 |
| Guizhou | 0.2531 | 0.175 | 0.1752 |
| Yunnan | 0.4099 | 0.4149 | 0.4197 |
| Xizang | 1 | 1 | 1 |
| Shanxi | 0.2211 | 0.1715 | 0.185 |
| Gansu | 0.2584 | 0.2689 | 0.2818 |
| Qinghai | 0.6392 | 0.4015 | 0.6492 |
| Ningxia | 0.7265 | 0.6626 | 0.6248 |
| Xinjiang | 0.2787 | 0.2856 | 0.8435 |

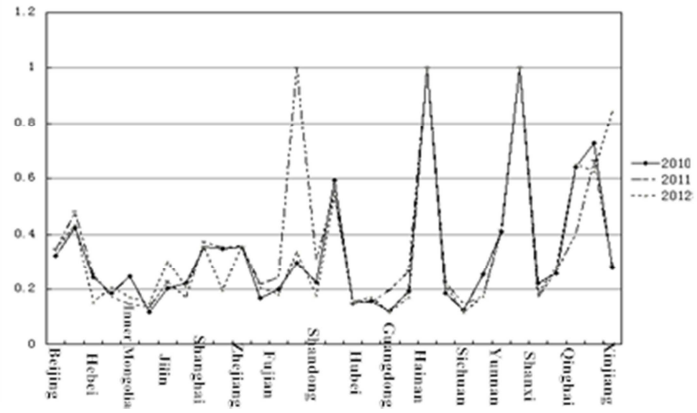


**Fig.2 Changing trends of the network system scores of each province in 2010- 2012**

According to the analysis of the provinces with unobvious economic efficiency and social governance efficiency such as Hebei, Liaoning, Anhui, Hunan, Sichuan and Shanxi, it is found that the network efficiency of these provinces is significantly behind other provinces, while the advantages of the provinces such as Beijing, Tianjin, Shanghai and Zhejiang are more obvious under the network efficiency. It is indicated that there is an important link between the economic development system and the social governance system. The economic development and the social governance promote each other and the whole efficiency scores are higher. Otherwise, the whole efficiency scores of the decision-making units are lower. Therefore, it is more reasonable to evaluate the efficiency of provincial units from the network.

*Comparative analysis of the empirical results under the dynamic network effects*

The same economic development and social governance indexes are selected. The collected index data in 2010-

2012 are brought into the dynamic network SBM model. The results are shown as follows (Table 7):

**Table.3 Scores of dynamic network efficiency of each province in 2010-2012**

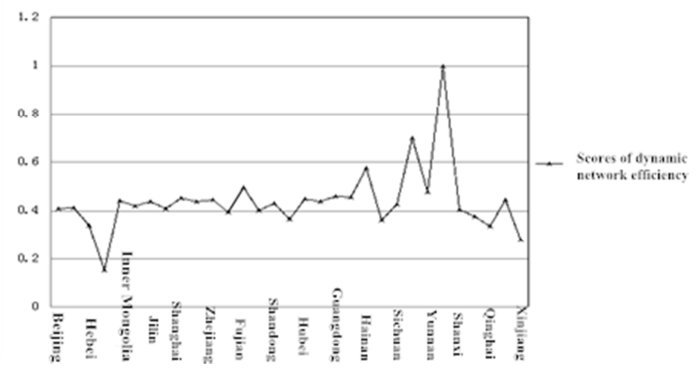


**Fig.3 Changing trends of dynamic network efficiency of each province in 2010- 2012**

In Table 3 and Figure 3, it is found that only the dynamic network efficiency score of Xizang reaches to 1, which is consistent with the economic development efficiency and the social governance efficiency in single stage. The efficiency of Hainan and Ningxia is also consistent with the network efficiency, the economic efficiency and the social governance efficiency in the analysis of single stage. The higher efficiency of these provinces is because of the distinctive natural resources. In recent years, they have undertaken the industrial transfer and the economic development has been gradually accelerated. It is more interesting that the efficiency scores of Fujiang and Guizhou are not significant compared with other provinces, but they have higher efficiency scores in dynamic analysis. It may be that the two provinces do better in the dynamic recycling of resources.

## CONCLUSION

The SBM model with negative output, the network SBM model and the dynamic network SBM model are respectively applied in evaluating the economic development efficiency and the social governance efficiency of 31 provincial administrative units in this paper. According to the single-cycle evaluation results, it is found that some central and western provinces such as Xizang, Inner Mongolia and Chongqing have maintained higher economy efficiency in recent years. In contrast, the economic efficiency of coastal economically developed areas has been decreased. In the aspect of social governance, the central and western provinces such as Xizang, Qinghai and Ningxia have maintained better social governance efficiency due to the better natural environment, small population and less investment in environmental governance. The developed areas such as Beijing, Tianjin, Shanghai and Zhejiang have higher social governance efficiency. These areas have gradually completed the economic transformation and a more perfect system has been established in the aspect of social security. According to the analysis of the network effects composed by economic development system and social governance system, the network efficiency of most provinces is lower than the single efficiency. The three efficiency values of Xizang all reach to 1. Through the analysis of dynamic network efficiency, it is found that the efficiency scores of Fujian and Guizhou in single stage are not significant and they have better scores in dynamic efficiency, which indicates that the two provinces have done relatively well in the aspect of dynamic recycling use of resources.

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